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BIENNIAL REPORT

OF THE

DEPARTMENT OF HIGHWAYS

OF THE

STATE OF CALIFORNIA

DECEMBER, 1906

N. ELLERY, - - - - - Commissioner



SACRAMENTO:

W. W. SHANNON, - - - SUPERINTENDENT STATE PRINTING
1906.

BIENNIAL REPORT

DEPARTMENT OF HIGHWAYS

STATE OF CALIFORNIA

1905-1906

COMMISSIONER

W. H. HARRIS



PRINTED BY THE STATE PRINTING OFFICE

1906

SACRAMENTO, CALIFORNIA.

OFFICE OF DEPARTMENT OF HIGHWAYS,

November 30, 1906.

To His Excellency, GEORGE C. PARDEE,

Governor of the State of California.

SIR: I herewith submit for your consideration the report of the Department of Highways, covering the period from November 1, 1904, to November 30, 1906, as provided for in Chapter CCLXXII of Statutes and Amendments, 1897; and, appended thereto, the Report of the Lake Tahoe Wagon Road Commissioner.

Very respectfully,

N. ELLERY,

State Highway Commissioner.

Attest: CLARK ALBERTI, Secretary.

REPORT OF THE DEPARTMENT OF HIGHWAYS.

Road affairs in this State for the past two years have not received sufficient public attention that proper remedial measures might be of general demand, but they are, however, none the less needed and desired. The lack of system still prevails and causes no end of monetary loss in both construction and maintenance—a fact patent to all who carefully study the conditions that surround them when traveling our highways.

Surely there is a slow growth toward ultimate permanent construction which is shown principally in bridge and culvert work, but as yet no great advance toward good roadbeds has been made. The causes for this lack of system are apparent.

The general plan of conducting our road business leads to no end of modes of building and repair. Various opinions and ideas of officials charged with the road business and who in many instances have had no proper training in road work, as their previous labors were applied along other lines, create too many plans for the work. In numerous instances, too, men have charge who make good and substantial progress in their work, but for some slight cause are superseded by others holding completely divergent ideas. These changes must have their bearing on the work, and consistently show in the mixed results. There are also local influences so potent in shaping the road expenditures as to often prevent good and permanent results.

The struggle of California road-builders to obtain from crude oil its full benefits to highway work has been of varied results. In some counties, through lack of proper application, selection, and treatment, oil for roads has fallen under the ban and its disuse advocated and accomplished; while in other counties intelligent use of oil has proven admirable as a road material and dust preventive. During 1906 instances came to the attention of this Department where oil was applied, without any preparation of roadbed, and allowed to flow as it would over the road surface. No effort to mix or hold the oil in place was made and resulted in a miserable, uneven, bad road. Such work is vitally wrong, uneconomical, and a positive setback to road improvement.

General evidence of the need of reform in the road system of this State is afforded by a consideration of the recurring attempts to change

the road laws. Every session of our Legislature brings forth various measures in an effort to rectify the faults manifested in the particular locality from whence the need of the change originated, but so far such measures have not struck the right remedy and have proven futile.

The yearly expenditures of this State for country roads, outside of municipal corporations, have now reached \$2,750,000. In addition to this it is estimated that \$250,000 per annum is expended from the county general funds for bridges and oil on the 50,000 miles of highways.

A public expenditure of such proportions should be directed partially toward permanent improvement. But before we can materially effect permanent work, this State must begin a practical object lesson in road construction and maintenance by giving some good main highways maintained by the counties under State direction. In fact, apply the State-aid plan.

This scheme of benefit is not new or untried. A great many Eastern states have adopted the plan and after several years of improvement under it, during which many miles of excellent and durable roads have been built and maintained, there is a general demand by their people for its extension. These states went through our experiences, and until they finally embraced the aid law, were continually tinkering with their road laws for relief.

For California this scheme will systematize road business, bring construction and maintenance under trained men, place at the disposal of the counties systematic and uniform plans, relieve much of local influence, be a practical educator, and thereby affect all road work to so great an extent that eventually when the improvement brings maintenance to its proper form, road taxation will materially decrease. Therefore, it is recommended that the following State-aid road law, patterned after the New York law, be enacted:

AN ACT TO PROVIDE FOR THE IMPROVEMENT OF THE PUBLIC HIGHWAYS, AND TO
MAKE AN APPROPRIATION THEREFOR.

The People of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. The Board of Supervisors in any county of the State may, and upon presentation of a petition as provided in section two hereof, must pass a resolution that public interest demands the improvement of any public highway, or section thereof, situate within such county, and described in such resolution; but such description shall not include any portion of a highway within the boundaries of any city or incorporated village; and within ten days after the passage of such a resolution shall transmit a certified copy thereof to the State Highway Commissioner.

SEC. 2. The owners of two thirds of the lineal feet fronting on any such public highway or section thereof in any county of the State may present to the Board of Supervisors of such county a petition setting forth that the petitioners are such owners and that they desire that such highway or section thereof be improved under the provisions of this Act.

SEC. 3. Such Highway Commissioner, upon receipt of such resolution, shall investigate and determine whether the highway or section thereof sought to be improved is of sufficient public importance to come within the purposes of this Act, taking into account the use, location, and value of such highway or section thereof for the purposes of common traffic and travel, and after such investigation shall certify his approval or disapproval of such resolution. If he shall disapprove such resolution, he shall certify his reasons therefor to such Board of Supervisors.

SEC. 4. If he shall approve such resolution, such Highway Commissioner shall cause the highway or section thereof therein described to be mapped both in outline and profile. He shall indicate how much of such highway or section thereof may be improved by deviation from the existing lines whenever it shall be deemed of advantage to obtain a shorter or more direct road without lessening its usefulness or wherever such deviation is of advantage by reason of lessened gradients. He shall also cause plans and specifications of such highways or section thereof to be thus improved to be made for telford, macadam, or gravel roadway or other suitable construction, taking into consideration climate, soil, and materials to be had in the vicinity thereof and the extent and nature of the traffic likely to be upon such highway, specifying in his judgment the kind of road a wise economy demands. The improved or permanent roadway of all highways so improved shall not be less than eight feet nor more than sixteen feet in width, unless for special reasons to be stated by such Highway Commissioner it is required that it shall be a greater width. He shall, if requested by the resolution, include provision for steel-plate or other flat-rail construction in double track.

SEC. 5. Upon the completion of such maps, plans, and specifications, such Highway Commissioner shall cause an estimate to be made of the cost of construction of the same and transmit the same to the Board of Supervisors from which such resolution proceeded together with a certified copy of such maps, plans, specifications, and of his certificate of the approval of the highway or section thereof so designated as aforesaid.

SEC. 6. After the receipt thereof, upon a majority vote of such Board of Supervisors, it may adopt a resolution that such highway or section thereof so approved shall be constructed under the provisions of this Act, or of any existing Act, and thereupon shall transmit a certified copy of such resolution to such Highway Commissioner.

SEC. 7. In case the boundaries of such proposed highway shall deviate from the existing highway, the Board of Supervisors must make provisions for securing the requisite right of way prior to the actual commencement of the work of improvement.

SEC. 8. Upon receipt of the certified copy of the resolution provided in section six, such Highway Commissioner shall advertise for bids once a week for four successive weeks in a newspaper published at the county seat of such county and in one such other newspaper as shall be deemed of advantage for the construction of such highway or section thereof, according to such plans and specifications, and award such contract to the lowest responsible bidder, except that he may in his discretion award the contract to the Board of Supervisors in the county in which such highway lies; *provided*, that they shall agree to do said work at a cost at least ten per cent less than the lowest bid received, and except that no contract shall be awarded at a greater sum than the estimate provided in section five. But if no bid otherwise acceptable be made within such estimate, such Highway Commissioner may amend his estimate, certify the same to the Board of Supervisors, and upon the adoption by it of a resolution as provided in section six based on such amended estimate, proceed anew to obtain bids and award the contract as herein provided. Such Highway Commissioner may reject any or all bids, and before entering into any contract for such construction he shall require a bond with sufficient sureties conditioned that if the proposal shall be accepted, the party thereto will perform the work upon the terms proposed and within the time prescribed and in accordance with the plans and specifications; and as a bond of indemnity against any direct or indirect damages that shall be suffered or claimed during the construction of such road, and until the same is accepted. The people of the State of California shall in no case be liable for any damages suffered. Partial payments may be pro-

vided for in the contract, and paid in the manner herein provided, when certified to by such Highway Commissioner, to an amount not to exceed seventy-five per cent of the value of the work done; twenty-five per cent of the contract price shall be retained until the entire work has been accepted. Whenever a county engineer or surveyor has been appointed or elected in the county in which such highway or section thereof is to be constructed, he shall have general charge and supervision of the work under the direction of the Highway Commissioner, and shall report to him from time to time the progress of the work and such facts in relation thereto as may be required. If there is no county engineer or surveyor, such Highway Commissioner shall have some competent person to superintend and have engineering supervision of the work.

SEC. 9. Two fifths of the expense of the construction thereof shall be paid by the State Treasurer upon the warrant of the Controller, issued upon the requisition of such Highway Commissioner, out of any specific appropriations made to carry out the provisions of this Act. And three fifths of the expense thereof shall be a county charge in the first instance, and the same shall be paid by the County Treasurer of the county in which such highway or section thereof is, upon the requisition of such engineer or surveyor; but the amounts so paid shall be apportioned by the Board of Supervisors, so that if the same has been built upon a resolution of said board without petition, forty per cent of the cost of construction shall be a general county charge, and twenty per cent shall be a charge upon the road district in which the improved highway or section thereof is located, and if the same has been built upon a resolution of said board after petition as provided in section two, forty per cent shall be a general county charge and twenty per cent shall be assessed upon and paid by the owners of the lands benefited in the proportion of the benefits accruing to said owners as determined by the County Assessor in the next section hereof.

SEC. 10. The Assessor of the county in which any highway or section thereof has been improved or constructed pursuant to petition as provided in section two of this Act, shall have power, and it shall be his duty upon receiving notice from the Board of Supervisors of the county of the cost of construction or improvement of such highway or section thereof in such road district, to assess an amount equal to twenty per cent of said total cost upon the lands fronting or abutting on such highway or section thereof. Such assessment shall be apportioned according to the benefits accruing to the owners of the lands so located, according to the best judgment of said Assessor, upon at least ten days' notice of the time and place of such apportionment to the persons affected thereby, and after such persons have had an opportunity to be heard, and the assessments so made when duly attested by the oath of such Assessor shall be collected in the same manner as the general taxes of such county are collected.

SEC. 11. The construction and improvement of highways and sections thereof, under the provisions of this Act, shall be taken up and carried forward in the order in which they are finally designated, as determined by the date of the receipt in each case of the certified copy of the resolution provided in section six by such Highway Commissioner as hereinbefore provided.

SEC. 12. Upon the completion of such highways or sections thereof so constructed by such Highway Commissioner and his acceptance of the same after payment has been made as herein provided, such Highway Commissioner shall inform the Board of Supervisors of such counties that the highways or sections thereof designated have been constructed as herein provided; and he may serve notice on said board to accept such highway thus constructed, which notice shall be filed in the office of the clerk of such county; and twenty days after service and filing of said notice, such highway or section thereof shall be deemed accepted by said Board of Supervisors of said county; and thereafter they shall maintain the same as a county road and apportion the expense as they may be empowered by law. The county wherein such improved highways lie shall care for and keep the same in repair under the direction and supervision of the State Highway Commissioner, and such rules and regulations as he may prescribe. Should the county fail to comply with said rules and regulations, then such Highway Commissioner shall

cause the maintenance work to be done, and the cost of the same shall be a county charge, paid for in the same manner as for other county roads.

SEC. 13. Whenever any county has had aid in building any such highway, and it seems advantageous to such Highway Commissioner that a section or sections of highway, not exceeding one mile in length, shall be constructed under this Act to connect these roads together, and would be a great public utility and general convenience, he may serve notice on the Board of Supervisors of such county, and shall file one in the County Clerk's office, designating the highway already constructed and the existing termini, and the section or sections, in his opinion, necessary to be constructed and the reasons therefor. And it shall be the duty of the Board of Supervisors to provide for the construction of such connecting highway or section thereof, within one year after the service and filing of such notice. The procedure for such work shall be in accordance with the provisions of this Act.

SEC. 14. There is hereby appropriated out of any money in the State Treasury not otherwise appropriated, the sum of fifty thousand dollars to carry into effect the provisions of this Act.

SEC. 15. The operation of this Act shall not be affected by any conflicting Act or conflicting part of any Act wherever the same may now exist, and the highways may be improved under this Act or any existing Act relating to roads.

SEC. 16. This Act shall take effect immediately.

That the extent of and interest in road improvement under the aid plan may be better realized, a resumé of the work undertaken and accomplished by various Eastern states is given:

New Jersey.—The first State-aid law became operative in 1892. One third of the expense of building State roads is borne by the State, and two thirds by the county. The State appropriates \$250,000 a year as State aid, the limit being \$400,000. Counties must assume maintenance. Miles constructed, 1,111; cost, \$1,925,441.

Massachusetts.—State aid established in 1893; the State pays three fourths, the counties one fourth. Six hundred and fifteen miles have been built, at a cost of \$6,330,000. The State also pays for maintenance. There are 20,000 miles of roads in the State, and it is estimated that 1,900 miles will ultimately be improved by State aid. The State appropriates \$450,000 annually for construction, and in 1905 appropriated \$60,000 for maintenance.

Connecticut.—State aid began in 1895. In towns where the valuation does not exceed \$1,000,000, the State pays three fourths and the town one fourth; where the valuation exceeds \$1,000,000, the State pays two thirds and the town one third the cost of construction. State payments are limited to \$225,000 for any one year. Towns must maintain the roads so built. Four hundred and fifty miles of gravel and macadam roads have been constructed, at a cost of \$2,573,574.

New York.—State aid was established in 1898, the State paying fifty per cent of the cost of roads, the counties thirty-five per cent, and the towns or abutting property owners fifteen per cent. From 1898 to July 1, 1905, a grand total of \$16,284,000 was appropriated by the

State, the counties, and the towns for the improvement, repair, and maintenance of public highways within the State, of which there are 74,097 miles. To July 1, 1906, 692 miles of road had been constructed by State aid. Maintenance is undertaken by the counties. The State has recently bonded itself for \$50,000,000—\$5,000,000 to be available each year for ten years, for the improvement of the public roads.

Vermont.—State aid inaugurated in 1898; the State pays one half, the county one half.

Maine.—In 1901 the Legislature provided that any city or town may receive from the State one half the sum, at least \$100, expended on some road within its corporate limits, to be designated as a State road. The maximum amount to be drawn by any town in any one year is \$300.

Pennsylvania.—The Legislature of 1903 passed a State-aid law providing that two thirds of the cost of building roads shall be borne by the State, one sixth by the county, and one sixth by the township. An appropriation of \$6,500,000 was made—\$500,000 for each of the first two years, \$1,250,000 for each of the next two years, and \$1,500,000 for each of the next two years. The State and the counties share equally the cost of maintenance.

Delaware.—Inaugurated State aid in 1903, the cost of roads being borne equally by State and county.

Ohio.—State aid was inaugurated in 1904, one fourth of cost of road construction to be paid by the State and three fourths to be a county charge—one third of said three fourths to be paid by the township. In apportioning the twenty-five per cent paid by the township, ten per cent is a charge upon the whole township, and fifteen per cent a charge upon the abutting property. Counties must maintain roads so built.

Maryland.—The Legislature of 1904 provided \$200,000 annually for macadam roads, one half the cost to be paid by the State and one half by the county. The amount received by each county from the State bears the same ratio to the total State appropriation as the public-road mileage of the county bears to the total public-road mileage of the State. Roads to be maintained by the counties.

New Hampshire.—The Act of 1905 requires each town to set apart for the main highways a portion of the money raised by local taxation for road purposes, the amounts so set apart ranging from twenty-five cents to \$1 on each \$1,000 of valuation, according to the total amount of valuation. To secure State aid the local authorities must raise an additional sum equal to fifty per cent of the said portion set apart for

main highways. State aid is given in amounts ranging from twenty cents to \$3 for every \$1 locally raised as aforesaid, according to the total valuation. The highways are maintained by the counties and towns.

Minnesota.—Act of 1905 provides that for State aid in road building one twentieth of a mill shall be levied on each one dollar's valuation of all taxable property; also sets aside for the same purpose all money accruing from investment of the internal improvement land fund. Money is apportioned to the counties according to area and expense of construction. No sum apportioned to a county shall exceed one third of the amount expended by the county.

Michigan.—In 1905 established State rewards to townships and counties that build gravel or macadam roads, of \$250, \$500, \$750, and \$1,000 a mile, according to kind of road built, when approved by the State highway commissioner.

SOME SUGGESTIONS IN CONSTRUCTION OF COUNTRY ROADS.

During the travel necessitated by the work of this Department, roads in various parts of California have been studied with a view to benefiting them by some of the simpler changes in construction. In the early location of a road very little forethought was given to its alignment or grade, so that in innumerable instances a slight change of location and grade will result in great reduction in cost of maintenance. Steep pitches occurring on the mountain roads should be, as far as possible, removed by the counties, so that the winter rains and melting snow will not destroy by erosion the roadbed and thereby cause each spring an excessive repair expense.

Good drainage should be obtained by crowned roadbeds and side ditches. But where water is conducted along the side of the roadway it should be diverted before too long stretches are reached. Culverts are needed at closer intervals as the grade increases, and in all cases should be made of lasting material. Salt-glazed, vitrified sewer pipe, where the expense is not excessive, gives an excellent and substantial culvert. In its use, however, the intake and outfall must be protected by stone work properly set in cement mortar. Preference is given to sewer pipe for the reason it is of smooth interior and far less liable to get stopped up than either wood or stone. From the experience on the Lake Tahoe State road, pipe culverts cost at least one third less than stone culverts in a granite country, and give far better results. Counties employing wood in culvert construction should, as rapidly as funds will permit, replace them with pipe culverts. The inauguration of this sole permanent road improvement would in a very few years

prove its efficiency and economy. In furtherance of a general adoption of this work there is given below a table, with the flow of water through pipe culverts.

<i>Grade of Pipe, 3 inches to 25 feet.</i>		<i>Grade of Pipe, 6 inches to 25 feet.</i>	
Diameter of Culvert, in inches.	Capacity of Flow, cubic feet per second.	Diameter of Culvert, in inches.	Capacity of Flow, cubic feet per second.
12 -----	3.4	12 -----	4.8
15 -----	6.3	15 -----	8.9
18 -----	10.4	18 -----	14.7
20 -----	13.8	20 -----	20.5
24 -----	22.7	24 -----	37.8
30 -----	41.6	30 -----	73.7

The grade may be increased as shown by the table and greatly increase the capacity.

Where culverts can not conduct or span the water, small bridges should be built on the most economical basis. Reinforced concrete has now so far advanced in structural practice as to give a reasonably cheap structure in all easily accessible locations for all the ordinary bridge lengths. It is practically indestructible. Therefore, this material and stone masonry, where stone is easily obtainable, if used in place of wooden or combination structures, will reduce expensive reconstruction to a minimum.

However, in isolated cases where neither of these materials is available or very costly of construction, wooden bridges may be allowable. At best, wooden structures made of the pine of the mountain districts and unprotected from the weather will have a life of only fifteen years. Economy suggests that such bridges be completely housed and thereby increase their life at least fourfold.

Numerous cases of too narrow roadbeds are encountered. Ten feet in width should be the minimum, in the opinion of most drivers, and then 18 by 50 feet turnouts should be provided at all points of vantage. The sharp curves of the roadway need an increased width, but not as generally practiced. It has been the custom to make the extra width on the turn. Experience, however, determines that the necessity for width is just on either side of the apex of the curve and thus give an opportunity to handle long teams.

One very difficult problem in road construction is the proper handling of adobe soil for roadbeds. A considerable mileage of country roads traverse this soil and are, during the winter months, practically impassable. One good and simple remedy is to saturate the adobe, when slightly plastic, with sand or fine gravel, that it may have a body and capacity to hold weight. Wherever sand is available it is suggested to the authority having such roads in charge, to give this plan a thorough test. Another matter clearly brought to the attention of this Depart-



YOLO COUNTY METHOD OF TREATING EARTH ROAD, AFTER OILING AND TOPPING WITH EARTH.

95-06743-7



WINTERS-DAVISVILLE OILED EARTH ROAD. ON LEFT, MAIN ROAD SMOOTHED; ON RIGHT, PART YET UNSMOOTHED.

95-06743-8

ment, is the care that must be exercised in graveling or macadamizing on adobe soil. A narrow strip of either material allows the vehicles to pick up the wet adobe on either side, and beginning at the road shoulders will gradually force the gravel or rock into the mud and create a rough road of adobe mud and uneven rocks. At all events, get the roadbed well drained and a width of roadway sufficient for the passage of vehicles. In general, the lasting quality of any road material is severely taxed to resist the wear where the wheels constantly follow in one line or rut. A traveled way of 16 feet in width is none too wide to avert this concentrated wear.

OILED ROADS.

No material is quite so important to our road improvement as crude asphaltic oil. It may be used as a dust preventive, a roof to shed the rain water from the foundation, and as a lubricant to reduce the rate of wear to the road surface. While these improvements are of vast importance when properly handled, it must be borne in mind that only partial results, and in many cases no results, are obtained with improper application, selection, and treatment of oil.

Upon inspection of oiled roads of this State it was found that no general system prevailed. In many cases, oil was applied to a rutty, uneven and worn out, and then allowed to collect in puddles. This was labeled an oiled road. It takes but a short time to lose faith in work under such methods and it has been due to this lack of preparation and care that so many counties have discontinued the use of oil. However, such work was not found on all roads visited, as several counties of California have excellent oiled roadways. A good oiled earth highway was particularly noticed in Supervisorial District No. 2, Yolo County, where a highly intelligent use of oil may be seen on the Winters-Davisville road. Here is an earth road of splendid cross-section, prepared and oiled at a cost not exceeding \$150 per mile, and creating a road at this figure fit for heavy travel as well as light vehicles. The plan followed in this work is presented as an extremely sensible and scientific solution of the problem.

The roadway is first cut out to the cross-section desired, with the crown easily decreasing in elevation to a slight gutter about seven feet from the property line, and from this point there is a rise to the edge of the right of way. The crown is not excessive, perhaps eight inches, thus giving ample opportunity for a lateral spreading of the travel. After the road is cut to a hard, even base and all weak spots remedied, oil is applied at the rate of one gallon to the square yard of surface; then the grader returns the earth, which was piled at either side of the part of road to be treated, immediately over the oiled portion.

While this is being done, a drag attached to the rear of the grader, as shown in the accompanying view, smooths the earth over the oil to a depth of four or five inches. After thorough rolling and compacting of the earth on the oil, travel is permitted on the roadway. At this point an excellent plan is used: The travel necessarily creates a rough surface, and if allowed to continue without any further work a very inferior road would result. But the grader and attached drag go over and smooth the surface as necessity requires, keeping the work in almost perfect shape. By simply repeating this process, with grader and drag, to keep the road smooth until the oil eventually comes up to the surface, an extremely hard, oiled road of earth is given. At any point, where there appears on the surface too much oil for the material, a local application of sand or earth is made. This process makes an oiled road by fully saturating the oil, giving it a body hard enough to withstand heavy travel with scarcely any indentation or drag to the tractive power.

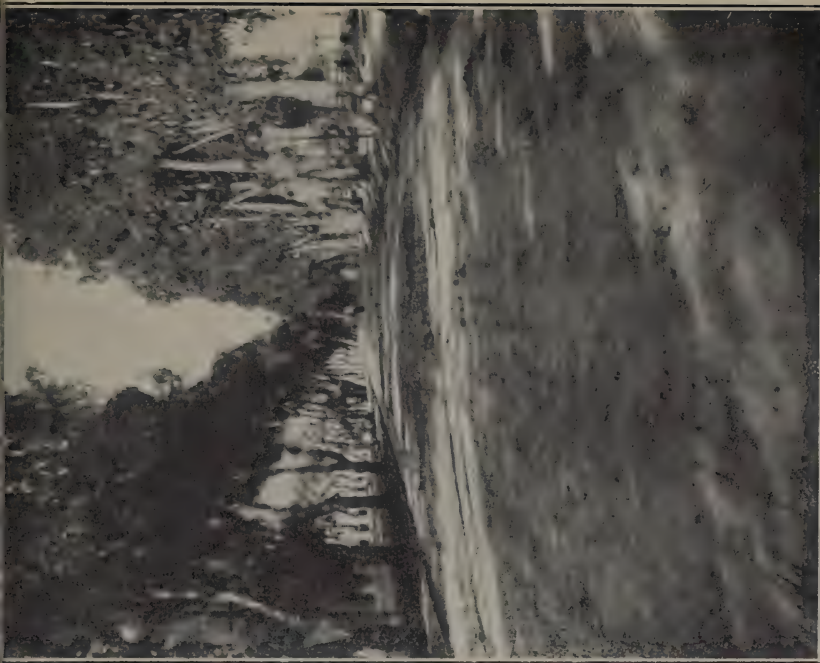
Upon examination of many miles of oiled country roads, it was observed that soft, plastic bunches of oiled material have accumulated near the edge of the travel, showing conclusively that too much oil was used for the material involved. The use of an excessive amount of oil has given rise to the teamsters' objection to the heavy pull—an objection well sustained by experience, but one dispelled by the foregoing method of oiling.

In southern California considerable mileage of good oiled roads may be found. Riverside County employs a method very similar to the one used in Yolo County, with remarkably fine results. The sub-grade is crowned to the proper cross-section, when it is watered and rolled thoroughly to a solid even form. Upon this is placed about four inches of granite stone found handily near, which is in turn wet and rolled until compacted. On this surface is sprinkled from one half to one gallon of heavy asphaltic oil to the square yard. Then over this is deposited about two inches of fine granite material, enough in each instance to completely keep the oil from reaching the surface for several days. Whenever oil appears in a slight puddle on the surface it is immediately covered with fine crushed rock. This method gives a road closely resembling a bituminous macadam pavement, and one which has a wearing capacity far beyond the life of the roads treated with a top layer of oil.

From the experience in our State on oiling roads, the following deductions drawn are paragraphed rather than placed in specified form, as too many conditions arise requiring special treatment in individual cases and therefore general specifications might be at fault for some special piece of work.



PALM AVENUE, RIVERSIDE. FOUR-INCH GRAVEL BASE, $\frac{1}{2}$ GAL. OF OIL TO THE SQ. YD. TWO YEARS OLD. PHOTOGRAPHED 1906.



MAGNOLIA AVENUE, RIVERSIDE. FOUR-INCH GRAVEL BASE, 1 GAL. OF OIL TO THE SQ. YD. ONE YEAR OLD. PHOTOGRAPHED 1906.

ROAD OIL.

Perhaps many miles of California roads have received applications of oil which contained but a small percentage of asphaltum, and which made a failure positive in such cases. The selection of a proper oil is very essential, affecting, as it does, the whole work. At the City Engineer's office, in Riverside, two specimens of oil were displayed, after evaporation. Both were originally of heavy gravity, and after reduction the asphaltum residuum in one sample was *nil*, while in the other sample a heavy percentage of asphaltum remained. Upon looking at those results it was plainly evident why some failures had occurred after considerable care had been used in road preparation. For such reason it is especially suggested that oil that is to be used for road purposes should be thoroughly tested for asphaltum and amount of foreign matter and water contained therein. Good road oil should contain forty per cent of asphaltum and have no more than three per cent of foreign matter and water.

Undoubtedly the best and simplest test of the road-making value of an oil is to evaporate a weighed sample in an open, metal dish, down to the hardness of commercial "D" asphalt and weigh the residue. This plan gives both the original asphalt and that formed during evaporation, and while this does not exactly correspond to the amount of asphalt created when sun-dried, yet the comparative values of oil are accurate. The only apparatus required for this test is an iron pan, a scale, and a heating apparatus.

Another item of interest and discussion in connection with oil for road building is whether it should be applied cold or hot. Good roads have been obtained by either process, but, as cold oil is considerably cheaper, my preference is for cold oil, allowing however, that where oil is very heavily asphaltic, heating may be required to give fluidity enough to apply the oil.

The selection of the oil is a matter of vast importance. Always require a test for asphalt contained, and foreign substance, and seek that quality containing the greatest percentage of asphaltum.

ROAD PREPARATION FOR OILING.

Earth Roads.—Roads made of earth present the easiest mode of construction and the least expensive, when first cost only is considered, but as such to have them good roads requires constant attention. They should be properly drained to meet all conditions of rainfall and crowned sufficiently to create a roof for the water to run off. Where oil is to be applied, the roadbed should be cut out evenly and compactly and solidly, in no case, however, leaving weak or wornout spots. Upon

this should be applied from three fourths to one gallon of good asphaltic oil, the amount varying to meet special conditions, and then immediately cover it with about four inches of earth. If sand or fine gravel is readily available, employ this material, as it gives a better body to the artificial bitumen. Then compact by rolling the earth upon the oil, and care for your roadway with a drag and grader as previously outlined. By all means give your road a chance to show its efficiency by properly caring for it.

Oil on Alkali.—Where the roadway is composed of earth containing alkali or lime a different plan must be followed. It is now known that the asphalt of the oil is disintegrated by either material into two substances, petrolene and asphaltene, neither of which taken separately has any road value. Therefore, to obtain an oiled road of any reasonable life we must cover the alkali soil with some material with which the oil must be incorporated.

GRAVEL ROADS.

The almost universal plan of making gravel roads in California is by dumping on the road unscreened gravel and allowing the travel to spread and pack it down. A change is here necessary for oiling purposes. First make a sub-grade of the given cross-section evenly compacted by wetting and rolling, and then apply four or five inches of the larger and heavier part of a screened gravel. Roll this well with about a ten-ton roller, and then apply about a gallon of oil to the square yard of surface. Upon this apply about three inches of fine gravel and sand, and then thoroughly roll again. Under such a plan there is no reason why gravel roads should not produce a very excellent road of good wearing quality.

Road materials in this State are so distributed that no section need be without some form of rock road. The streams of the valleys contain extensive beds of gravel which may be used to construct oiled graveled roads of durability.

MACADAM ROADS.

What applies to the sub-grade for gravel roads is also applicable to macadam construction. On the sub-grade from four to six inches, according to foundation, of crushed rock should be applied and thoroughly wet and rolled. On this apply one gallon of heavy asphaltic oil per square yard of surface, and then cover with two inches of finely crushed rock. Upon this should be placed about one inch of screenings. This material must then be thoroughly rolled and cared for until the oil has reached or nearly reached the surface of the



BROCKTON AVENUE, RIVERSIDE. FOUR-INCH MACADAM BASE, $\frac{1}{2}$ GAL. OF OIL TO THE SQUARE YARD. TWO YEARS OLD. PHOTOGRAPHED 1905.



NORTH ORANGE AVENUE, RIVERSIDE. OILED TWO YEARS AGO. PHOTOGRAPHED 1906.

screenings. Wherever there is a tendency for oil to collect on the surface cover it with more screenings.

In all instances where oil is applied beneath the real surface of the roadway, there is a tendency for it to rise and not to penetrate downward in direction to any great extent. This is due to the weight above forcing the material down, and the oil ascends, filling the interstices. It is my firm belief that this plan, if properly followed out, will give exceedingly gratifying results. If the top rock is hard the oil will extend its wearing life very materially by acting as a lubricant in prevention of the grinding process, and by having a depth of oil, say four inches, in the road gives an elastic binding which takes up the weight and shocks of travel, reducing the wear and the raveling of the ordinary macadam road.

REPAIRS TO OILED ROADS.

Whenever a weak spot or rut shows in an oiled road it should immediately be repaired by cutting out a section with vertical sides, which shall be filled, in the case of gravel or macadam, with mixed oil and fine gravel, or fine crushed rock. On oiled earth roads the rut should be cut out, oil poured in, and then the excavation filled with about three inches of soil or preferably sand. Thoroughly tamp all material placed for repairs and in all cases make the fill slightly above the road surface to allow for settlement. The vertical sides to the excavation give shoulders beyond which the traffic can not shove along the new material or scatter it from its position.

In the appendix to this report are given two sets of oiled road specifications—one for streets in Los Angeles city and the other for streets in Santa Monica. The latter consists of a departure from the plan outlined and suggested above, but as yet this Department has no actual knowledge of its results. The result of road oiling throughout California, after a very large expenditure by the counties, has not proven satisfactory, except in a few counties and localities. With this in mind it is earnestly believed an appropriation from the State for experimental and object-lesson oiled roads, to be applied in about five sections under different existing conditions, would prove highly beneficial to those having charge of county roads.

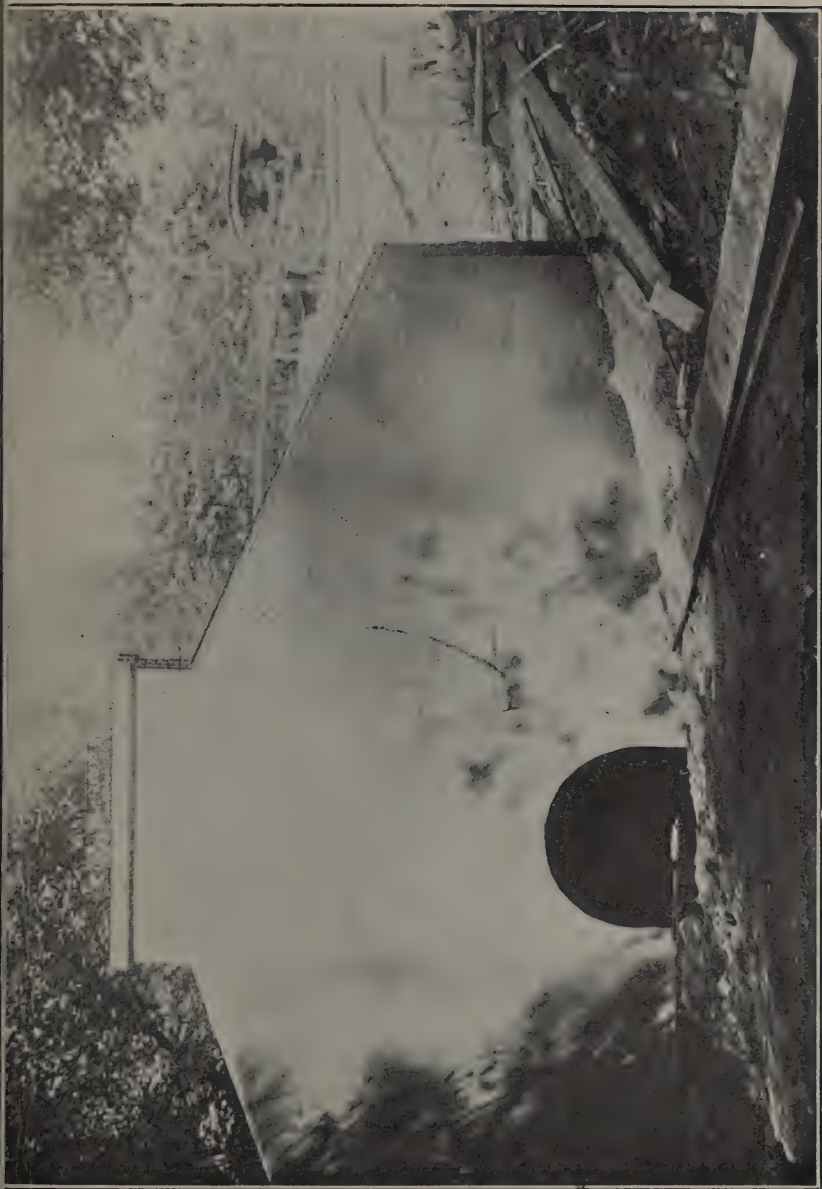
From the data collected by this Department there seems to be little doubt of the extreme importance of oil in making roads, and I therefore recommend that an appropriation of \$7,000 be made for experimental, object-lesson oiled roads.

LAKE TAHOE WAGON ROAD.

This Department has, for the past two years, advised with the Commissioner of the Lake Tahoe Wagon Road on all matters of improvement of the road. By the powers given the State Commissioner by the Act of 1903, relating to the care, management, and protection of State roads, and the Act of 1905 for the construction of permanent bridge work on the Lake Tahoe Wagon Road, duties devolved upon this Department, the carrying out of which led to the thorough inspection of all work done on the road and the ascertaining of a good knowledge of its needs.

During the Legislature of 1899 there was an appropriation made for the construction of certain improvements and for a survey of the road. The State Commissioner under whose charge it was placed began the survey September 27, 1900, and continued the work until the exhaustion of the funds available therefor. The survey, as it stands to-day, extends over twenty-five miles of the sixty miles of the road. On the work completed all crossings, topographical features, widths of road, grades, and permanent survey monuments were marked and set. For the purpose of marking the total survey, milestones cut of granite, at Folsom, of the size of 18 inches in width, 6 inches in thickness, and 54 inches in length, and indicating the distance to Placerville, were delivered at Riverton, where now all but those employed on the surveyed part are lying by the roadside. Without further delay, the remaining thirty-eight miles of the road should be surveyed, so that the setting and placing of the milestones may be completed. I therefore again recommend an appropriation of \$2,000 for this work, to be expended under the direction of this Department.

The Lake Tahoe Wagon Road originally had all structures such as culverts and bridges built of wood, and all places where culverts with fill were required the poorest construction of wood with brush and log fill was used. In numerous places these fills sag and completely give out so that travel can not pass. It has been the policy of this Department to wait until any structure becomes unserviceable and then recommend its construction in permanent form. Thus all culverts, in the past five years, have been reconstructed of stone or vitrified salt-glazed sewer pipe, and culverts with fill of the same materials with a heavy stone wall to protect the roadbed. The bridges, too, with one exception at Strawberry, have been constructed of permanent material. On August 15, 1906, the road possessed fifty-two vitrified pipe culverts, ten pipe culverts with finely made walls and fill, eleven stone culverts, nine stone culverts with heavy stone walls and fill, and fourteen permanent culverts of either pipe or stone from the Five-Mile House to the western end.



LAKE TAHOE WAGON ROAD. NEWLY CONSTRUCTED CONCRETE CULVERT AT OGLESBY CANYON.

Additional to this, one reinforced concrete culvert and the fine cut ashlar granite stone bridge of 81 feet span at Riverton, represent permanent work. To complete the work of permanent reconstruction on this road, a careful count, made August 16, 1906, gives the following requirements: Excluding those culverts required on the grade from the summit of the road to the Little Truckee River, one hundred and fifty-seven culverts, eight bridges of 20 to 30 feet span, and one structure 50 feet in span.

On account of the great many culverts needed on a mountain road, there must necessarily be a large expense attached to their replacement, and in the case of the Tahoe road the work progresses slowly, as only the funds left after the roadbed is maintained go into culverts. One source of extreme inconvenience on the western nine or ten miles of the road is the light, thick dust in the summer. Each spring this part of the road must be recrowned and worked over with a grader. If oil could be effectively applied to this very light reddish soil, it would result in a very material saving to the State. It is therefore recommended that an experiment with oil be made on the Lake Tahoe Wagon Road and \$1,000 be appropriated therefor.

Under the statute of 1905, appropriating funds for the construction of permanent bridge work on the Lake Tahoe Wagon Road, the State Commissioner was authorized to make plans and specifications for the two specially intended improvements—the Oglesby Cañon bridge and the Trout Creek bridge.

On April 22, 1905, I visited and made measurements sufficient for the location in line and profile of the Oglesby Cañon structure. It was decided to build a concrete culvert reinforced with railroad iron which was owned by the State and of little other use. Plans and specifications were drawn and filed in the office of the Department of Highways, and a view of the structure accompanies this report. On August 4, 1905, advertisements inviting proposals were inserted in a Sacramento paper and in a Placerville paper. In response to which but two bids were received, as follows:

T. M. Burns, Sacramento.....	\$950.00
Jenkins & Wells, Sacramento.....	1,094.00

As the bids appeared high, Mr. Lyon, the commissioner, was advised to reject them and readvertise, which was done. In response to the second advertisement three bids were received, as follows:

G. S. Morton, Placerville.....	\$1,027.00
James McGillivray, Sacramento.....	848.00
T. E. Clark, Sacramento.....	846.00

After consideration, Mr. T. E. Clark was granted the contract on August 21, 1905, for the sum of \$846, the structure to be completed

October 5, 1905. On this last mentioned date I examined the reinforced concrete culvert built by Mr. Clark and found it completed according to specified measurements. As Mr. A. S. Lyon, the commissioner, had charge of the work through his inspector, I depended upon their report relating to the foundation work. Such a report, over the signature of the inspector, was received and filed in the Department of Highways, and Mr. Clark was paid the contract price of \$846, plus \$25 additional on an agreement entered into by Mr. A. S. Lyon and Mr. T. E. Clark and for extra elevation to the wing walls above that specified. Before the twenty days allowed for holding the bond for defective work had expired, Mr. Lyon found, by a washout at the intake of the structure, a lack of proper foundation work and reported such condition to this office. On November 7, 1905, I visited the structure in company with Mr. A. S. Lyon, and had laborers expose the foundation at several points. The lack of proper work was plainly visible, so upon my return to Sacramento Mr. Clark was requested to place the foundation in the required specified shape and remedy three cracks in the concrete. He sent men to do the work and spent \$75 thereon. This work, upon a second examination, was not entirely satisfactory, so the cash bond of \$100 is still in Mr. Lyon's possession. When this needed foundation work is completed during the early spring, the State will acquire a good, serviceable and permanent structure.

After the trouble encountered in the construction of the Oglesby Cañon culvert it was decided to build the Trout Creek bridge by day labor. Consequently, plans and specifications were drawn by me for a 26-foot segmental stone arch bridge. The structure is to be built of squared rubble granite and its abutment foundations both rest on bed-rock. Mr. Lyon, at this date, has both abutments built to the springing line and the stone cut and the apparatus for building and cement on the ground, so that the work of completion will go on as early as Lake Valley may be entered next spring.

Under the present law, the Commissioner of the Lake Tahoe Wagon Road has direct charge of the road and the expenditure of the maintenance appropriation, thus dividing the State road business in an unsystematic and uneconomic manner. Believing the work could be more advantageously done if directly under the supervision of the Department of Highways, the following law is recommended:

AN ACT TO PLACE THE LAKE TAHOE WAGON ROAD UNDER THE CARE, CONTROL, MANAGEMENT AND SUPERVISION OF THE DEPARTMENT OF HIGHWAYS OF THE STATE OF CALIFORNIA; TO PROVIDE FOR NECESSARY ALTERATIONS AND EXTENSIONS OF SAID ROAD, AND THE REPAIR AND CONSTRUCTION OF THE ROAD STRUCTURES THEREON.

The People of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. On and after the thirtieth day of June, A. D. nineteen hundred and seven, the Department of Highways, State of California, shall have the care, control, management, and supervision of that certain wagon road belonging to the



SONORA AND MONO ROAD, ON THE "GRADE" TO THE SUMMIT, ELEVATION 7,000 FEET.

State of California known as the "Lake Tahoe Wagon Road," and situated in the county of El Dorado, in said State, commencing at the junction of the said road with the Placerville and Newtown road, a short distance from the village of Smith Flat, in said county of El Dorado, and running thence to a point on the east boundary line of said State at or near Lake Tahoe.

SEC. 2. It shall be the duty of the Department of Highways to keep said road, and the bridges and culverts thereon, open to travel at all times, except when prevented by the severity of the elements. It shall repair and rebuild said road, or any of the structures thereon, when in its judgment necessary and there are funds provided therefor. The Department of Highways may alter or change the route of said road, and may and shall do all things necessary or proper to care for, manage, maintain, improve, protect, alter, or extend said road, together with its road structures, and in so doing said Department of Highways is authorized to employ assistance, and to procure all material and property, real and personal, in its judgment necessary therefor.

SEC. 3. The Department of Highways shall have power to appoint a superintendent of the Lake Tahoe Wagon Road, who shall hold office at the pleasure of the Department. Such appointee shall not be eligible for such appointment unless possessing special qualifications for the duties devolving upon said office. Such superintendent shall receive six hundred dollars per annum in salary, and his necessary traveling expenses while in pursuance of his duties. Said salary shall be paid in the same manner and at the same time as that of other State officers.

SEC. 4. All Acts or parts of Acts in conflict with the provisions of this Act are hereby repealed.

SEC. 5. This Act shall take effect and be in force from and after June thirtieth, nineteen hundred and seven.

THE SONORA AND MONO ROAD.

The Legislature of 1905 appropriated \$20,000 for the construction of bridges, culverts, and grading on the Sonora and Mono State road, in addition to the maintenance appropriation of \$4,000 per annum. With the meager allowance prior to this appropriation, nothing except necessary temporary repairs and drainage could be undertaken. Since the spring of 1905, however, the work has progressed satisfactorily. Ditching has been generally done, the Eagle Creek bridge, a wooden structure of 50 feet span, has been reconstructed; the lava cap at the western end of Bald mountain, over which the road is built, gave annual trouble until a ditch was cut in solid rock, on the upper side of the road for 1,500 feet; sixteen stone culverts have been built, and about ten miles of filling in over granite boulders has been accomplished.

During the year 1906 much work has been done in coöperation with the Union Construction Company, a corporation desirous of getting water power from a point near Baker's station on the road. They applied for permission to put men on the road and work it from the western extremity to Baker's station, a distance of about thirty-eight miles. This was granted without delay and also coöperation extended from this office. Thus, during 1906, said company cut out the roadway for this distance, to 16 feet in width, taking out all protruding rocks, cutting out the brush and timber, and smoothing the roadway. This

Department bought two dump-carts, 1,730 feet of salt-glazed vitrified sewer pipe, and eighty sacks of cement, to assist in the work. With the carts we surfaced the Patterson grade five miles in length over one of the rockiest and roughest stretches of the whole road. The pipe and cement were shipped to Middle Camp near the road and will be placed next spring by the company in all places where culverts are needed on the first thirty-eight miles. This will give all permanent culverts for the first thirty-eight miles of the road and relieve all necessary maintenance expense hereafter on this line of improvement.

From the summit of the road, at the junction of Mono and Tuolumne counties, to Baker's station, the road was kept passable for travel, while most of the work was done in conjunction with the crew of from two hundred to three hundred men employed all summer by the aforesaid company, under the direction of this Department. Consequently, the road derived vast benefits from this plan with but little cost to the State.

The main bridge over the Stanislaus River was reconstructed of wood by the company and will be housed-in next spring by this Department, thereby prolonging its life at least fourfold. A full and complete design of a rubble stone bridge of 50 feet span was made for the above crossing, and bids advertised for. Upon the receipt of only one bid from Mr. O. L. Morton, July 17, 1906, for \$9,800, and having the assurance that the Union Construction Company would build a first-class wooden structure without cost to the State, it was rejected.

Next spring this Department may, from the balance of over \$13,000 in the bridge, culvert, and grading appropriation, do much work on the remaining forty miles of road. That part of this road contained in Mono County may be benefited by several changes in alignment and grade. One particular and very essential change is the Quinlan grade—a piece of road traversing a slide clay bank, and which can be entirely avoided by lengthening the road about a quarter of a mile. This, with some minor changes of line, should be proceeded with immediately. It is therefore recommended that the State Department of Highways be vested with power to obtain or condemn rights of way for State road purposes in the name of the State.

During August, 1906, the old combination bridge at Riverton, on the Lake Tahoe Wagon road, was torn down and the iron transported to Junction, Mono County, for use in the construction of a bridge over the West Walker River. The present structure at this crossing is dangerous and will be torn down as soon as the other material may be gotten on the ground in the spring.

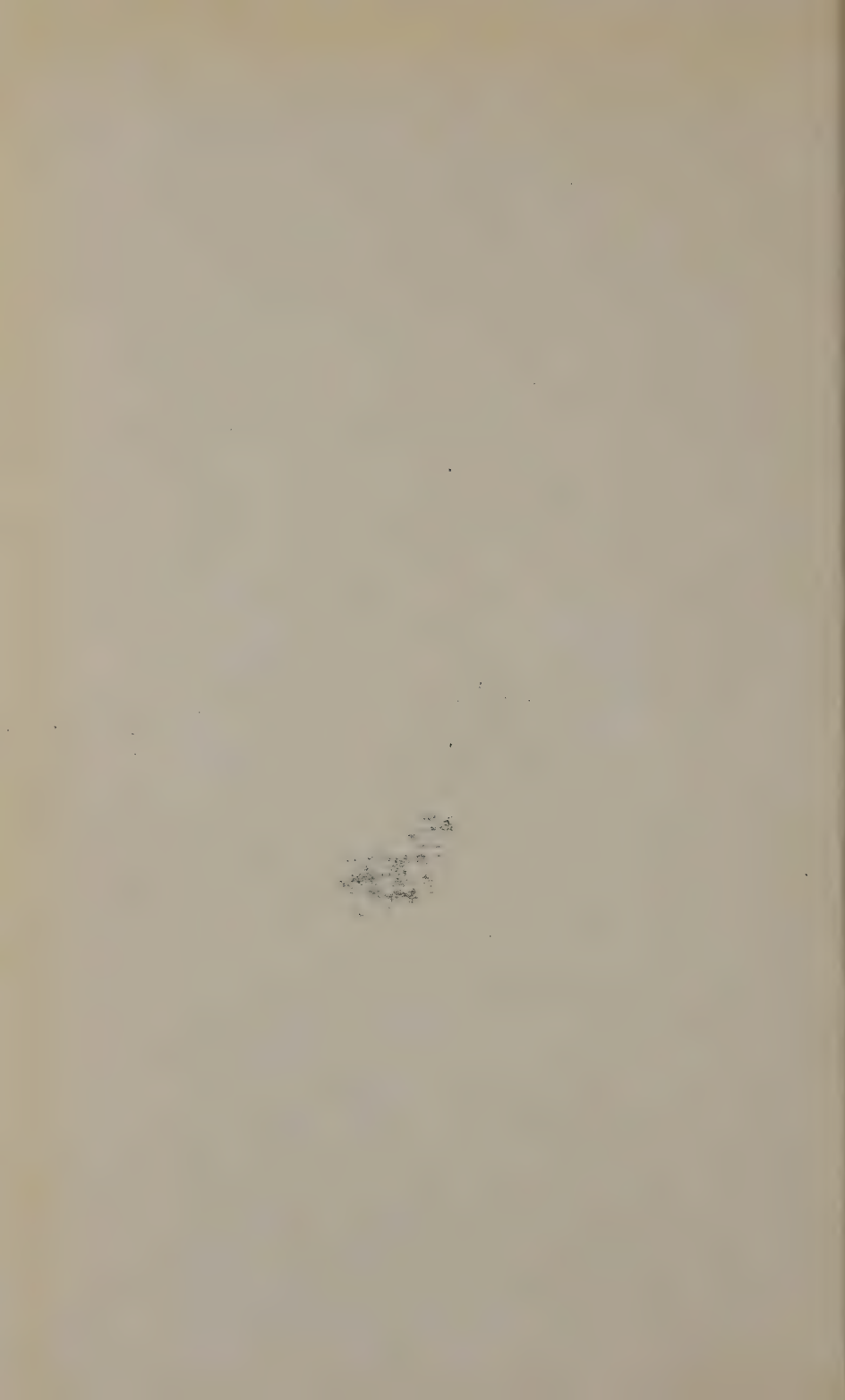
For a mountain road traversing the Sierra Nevada Mountains and seventy-eight miles in length, the present maintenance fund appropriation of \$4,000 per annum is wholly inadequate. It is therefore recommended that this sum be increased to \$6,000 per annum.



MONO LAKE BASIN ROAD, NEAR WARREN CREEK, SHOWING BROKEN ROCK.



MONO LAKE BASIN ROAD, SHOWING ROCK BLAST FOR ROADBED IN LEFT-HAND CORNER, AND ROAD LINE.



MONO LAKE BASIN ROAD.

The construction of this road has been materially retarded by the lack of labor and the short seasons during which work can be accomplished on it. Under the contract of Mr. James Touhey for the eastern end of 4 miles 1,010 feet of the road; there was expended by this Department, through its foreman, Mr. T. Silvester, the \$3,500 contract retention money and \$941.80 of the cash bond of \$1,000 held for the faithful performance of the work. Mr. Touhey failed to comply with the specifications, and after due notification to remedy the defects of his work, was, under the terms of the contract, relieved of further work.

This portion of the road is now in good shape, and a detailed list of expenditures from the bond money is given in the appendix to this report. The upper or western end of the road, 5 miles 593 feet in length, is now under contract to Mr. J. F. O'Brien of San Francisco, for the sum of \$23,861. In 1905, his first year of work, there was built two miles of the most difficult part of the road, thus leaving about one half mile of road to reach Rhinedolla Lake, where the work for the remainder of the distance is comparatively easy of construction. In 1906, through a late spring and heavy snows and a very great lack of labor in Mono County, only \$590 worth of work was done on the contract. The State Highway Commissioner especially investigated the labor problem with relation to the road and found it highly improbable that much work could be done, therefore the time of completion has been extended to September 20, 1907. The great difficulty encountered in carrying out this work on the second contract has been augmented by the mountain side giving way under a heavy blast, so that the resulting chasm of 400 feet must be bridged for 25 feet by the contractor. Steam drills have been employed in cutting away the solid granite rock for the roadway. Nearly all the roadbed must be made by hauling material from nearby pits, thus creating a surface on the solid or broken rock.

Where the road traverses a talus mountain, both lower and upper retaining walls were necessary for a distance of 3,300 feet each. No doubt when completed this road will present some of the most difficult of mountain road work, and to the increasing travel of that section one of the finest scenic routes of California.

At the session of the Legislature in 1905, there was appropriated \$500 per annum for the maintenance of the finished part of this road. Very nearly all of this amount has been expended in removing the earth and rocks that rolled into the road from the mountainside above the road. A new road cut into the mountain as this one has been, has, for four or five years, a great amount of loose material to be removed each spring. This appropriation should, therefore, certainly be increased to \$1,000 per annum, so that proper maintenance may be obtained.

ALTURAS-CEDARVILLE ROAD.

The first State aid to road construction in the coöperative sense was extended to Modoc County in the reconstruction of the Alturas-Cedarville road. In pursuance of the terms of the statute appropriating \$7,000 for the work, available in two equal parts for the years 1905 and 1906, the State Highway Commissioner visited the road May 25, 26, and 27, 1905, and outlined the most urgent needs in reconstructive work. In company with Mr. H. S. Smith, who was placed in charge of the work, and some citizens of Modoc County, a route was gone over entirely changing the present road in an endeavor to avoid the bad adobe soil on the western part of it. Various arguments were brought to bear in favor of the change, but after careful examination, which failed to show whereby benefits could be derived by such change, it was decided to adhere closely to the old line of road, changing local grades or alignments where certain improvements could be made. With this end in view, Mr. Smith was given instructions to widen out the road in narrow places, change the grade at many points selected by myself, fill the Stockdale slough—a very low, muddy sag—place stone culverts on new work, and get the best grade and alignment possible under the conditions. The county of Modoc, through its supervisors, appropriated \$3,000 to be expended with the State money and under the charge of this Department.

Two very bad locations of road near the Warner Range Mountain summit, one on either side, were re-located and re-constructed with wide roadbed and easy grades. On the west side of the summit there was an eighteen per cent grade on a turn which, in the winter time, from all accounts, was covered with ice and snow, making a most difficult place for any kind of team. This was changed by swinging to the north, thus giving more distance with an even grade of six per cent for about one half mile and more exposure to the sun. On the east side of the summit, the new grade was made above the old one for 8,050 feet at six per cent grade, again reducing a mean, heavy pull. All work was done with the idea of permanency, all bridge abutments being of dry rubble masonry, and the fill work at Stockdale slough was for the whole distance on both sides ripped with stone, while much permanent stone walling was built.

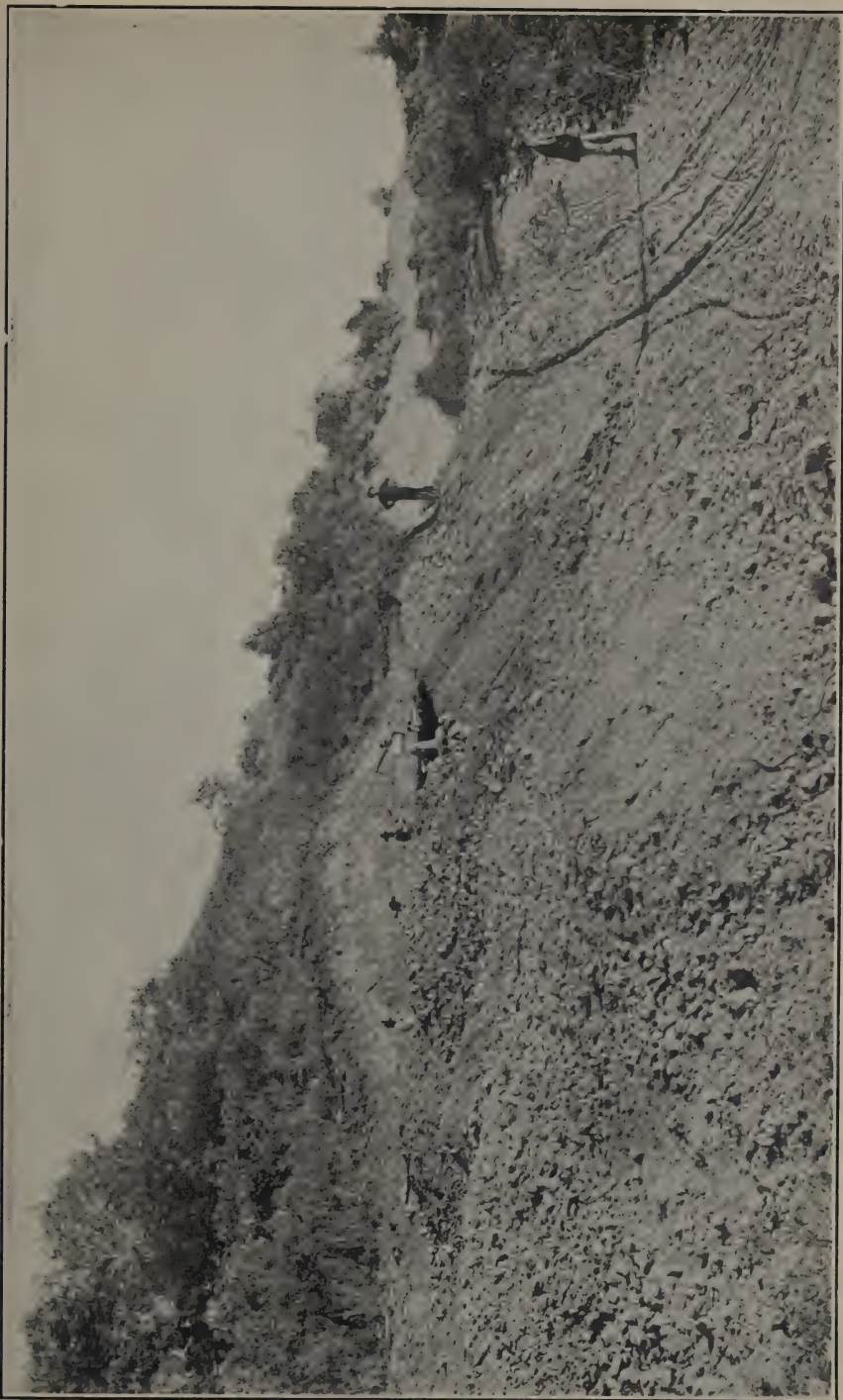
The work, covering a period of two years, is best explained by Mr. Smith's reports to this Department:

REPORT ON ALTURAS-CEDARVILLE ROAD.

NOVEMBER 10, 1905.

MR. N. ELLERY, *Commissioner of Highways, State of California.*

SIR: As there was great need of turnouts on this road, the first thing done was to remedy this defect. We widened the road at various sharp turns, not unnecessarily cutting or filling. This made our work quite rapid at the start, but we shortly struck rough and rocky ground, necessitating the use of pick and shovel



ALTURAS AND CEDARVILLE ROAD, AT WORK REDUCING STEEP GRADES NEAR SUMMIT OF WARNER MOUNTAINS. (OLD ROAD ON RIGHT SHOWING EXCESSIVE GRADE.)



ALTURAS AND CEDARVILLE ROAD. NEWLY CONSTRUCTED 6% GRADE, TAKING PLACE OF OLD ROAD IN PLACES 18% AND 20%.

95-06743-9

almost exclusively. Our first work began about one mile westerly from Cedarville, from which point we continued up the mountain in the direction of Alturas, doing the following work:

For 305 feet cut into the bank 4 feet; average cut, 6 feet; gave width of 14 feet.

For 90 feet cut into the bank 4 feet; average cut, 4 feet; very hard.

For 120 feet cut into the bank 5 feet; average cut, 3 feet; all blasting.

For 240 feet cut into the bank 3 feet; average cut, 10 feet.

For 45 feet filled outer edge $2\frac{1}{2}$ feet in depth, giving wide roadway.

For 60 feet filled outer edge 3 feet in depth, giving wide roadway at water trough.

At this point a stone culvert 20 inches by 20 inches by 20 feet was constructed, the rock for which was obtained from blasting a large boulder protruding from the bank into the road. We then made a cut into the bank 8 feet around a very sharp curve for a distance of 180 feet. Average cut of bank 15 feet deep. At the end of this cut we encountered a very large boulder 18 feet by 36 feet, which was blasted and used for retaining walls and fill below. Around this large rock was considered one of the most dangerous places, being so slippery in winter. From here we cut and filled the road, evening it to Cressler's cabin to an average of eight per cent. Another bad place remedied: The creek 150 feet below the road each winter cut away its bank, causing the whole side hill to give way, so that it had been thought impossible to save the roadbed at all at this point. Under the direction of the State Highway Commissioner we cut away the creek bank for 580 feet in length and 25 feet in height, making a slope of one to one. Continuing we cut and filled as follows:

For 50 feet cut into bank 3 feet; average depth, 8 feet; built rock wall and filled lower side.

For 102 feet cut into bank 2 feet; average depth 30 feet; filled lower side.

For 147 feet blasted out all protruding boulders.

For 327 feet cut into bank 3 feet; average depth, 5 feet; filled lower side.

For 51 feet cut into bank 10 feet; average depth, 6 feet; making a turnout.

For 144 feet cut into bank 4 feet; average depth, 8 feet; filled lower side.

This finished the work for this year on the eastern slope of the summit except near the top, where the following work was done:

For 45 feet cut into bank 3 feet; average depth, 6 feet; built wall 45 feet by 6 feet high.

For 182 feet cut into bank 4 feet; average depth, 3 feet; filled lower side.

For 200 feet cut into bank 2 feet; average depth, 3 feet; filled lower side.

For 100 feet cut into bank 4 feet; average depth, 3 feet; 30 feet through solid rock.

Entire distance was walled 2 feet in elevation.

At this point a culvert 20 feet by 36 feet by 30 feet was built and filled over to a depth of 18 inches. The summit itself was cut for a distance of 100 feet, 30 inches deep and 70 feet wide, to allow a suitable place for heavy freight wagons to couple up. The grade on the old road was very rough and uneven, averaging about fourteen per cent. From the point of commencement to the summit the new work reduces the grade to an eight per cent average.

We now commenced work on the western side of the mountain 250 feet from the summit and turned to the north, leaving the old road entirely. This change was very essential, as one turn contained a grade of eighteen per cent and was practically impassable during the winter. The following work was here required:

For 170 feet a thorough cut of 10 feet in depth; hard soil was blasted.

For 100 feet a thorough cut of 4 feet in depth.

For 76 feet a cut and fill of 3 feet, done with plow and scraper.

Here was placed a stone culvert 24 inches by 24 inches by 75 feet, and fill made.

For 57 feet a fill 10 feet in depth, with retaining wall each side, average height 8 feet.

For 100 feet thorough cut of 8 feet in depth.

For 67 feet, fill of 7 feet to a bridge.

This bridge structure is composed of stone abutments and hewn timbers of the following dimensions:

8 stringers.....	14 in. x 16 in. x 24 ft.
19 pieces.....	10 in. x 14 in. x 19 ft.
2 sills.....	10 in. x 14 in. x 22 ft.
2 wheel guards.....	14 in. x 16 in. x 26 ft.
Abutments.....	24 ft. x 15 ft. high.

There was used eighty gallons of coal tar upon the joints and woodwork of the structure and by ascertained figures sawed lumber would have cost \$190 more delivered than the used hewn lumber.

From the bridge the work was carried forward as follows:

For 350 feet, fill of 10 feet in depth; walled whole distance, 11 feet high.

For 175 feet, cut of 8 feet in depth; filled on lower side.

For 350 feet, fill of 8 feet in depth.

For 200 feet, cut of 8 feet in depth, through lava ledge.

For 250 feet, cut of 2 feet in depth, through lava ledge.

A stone culvert of 20 inches by 24 inches by 40 feet dimensions was constructed, when we continued cutting and filling and building walls.

For 120 feet, fill of 15 feet in depth; built wall both sides, 15 and 20 feet high.

For 270 feet, cut of 3 feet in depth; fill on lower side.

For 162 feet, cut of 5 feet in depth, through solid rock.

For 335 feet, fill average 6 feet in depth; built retaining wall lower side.

For 450 feet, cut average 3 feet in depth; fill lower side through brush and timber.

For 210 feet, fill average 4 feet in depth; wall lower side.

For 250 feet, cut average 2 feet in depth; fill lower side.

For 177 feet, cut average 9½ feet in depth; solid rock.

For 60 feet, fill average 6 feet in depth; wall lower side.

For 75 feet, cut average 3 feet in depth; wall lower side.

For 450 feet, cut average 3 feet in depth; fill lower side.

At the last stretch the old road is entered, where we made a clearing 600 feet long through heavy timber to avoid a bad, slippery grade and constructed thereon a temporary bridge. After completing this work we moved to Stockdale slough, where two bridges of 16 feet span and 14 feet in width were built. Their stone abutments are 16 feet by 4 feet in elevation. All wood work on the superstructures was thoroughly tarred at joints and connecting points. Along the roadway, across the slough, we laid a riprap wall on each side of the road for a distance of 687 feet, or a total of 1,374 feet. The average height of this work was 4 feet, width at base 4 feet, and sloped off to 1½ feet at the top. Between these walls was a fill of 18 inches of rock and covered with 6 inches of gravel.

As our yearly appropriation was getting low we concluded to drop work at this point, leaving 365 feet to be finished next year. We, however, gave it a coating of 18 inches of gravel, thus insuring the road until work is completed upon it, which can be done for \$250.

Respectfully submitted.

(Signed) H. S. SMITH,
Engineer and Superintendent.

For the year 1906 Mr. Smith continued on the work and reported as follows:

REPORT ON FINAL WORK ON THE ALTURAS-CEDARVILLE ROAD.

OCTOBER 30, 1906.

MR. N. ELLERY, *State Highway Commissioner, Sacramento, Cal.*

SIR: In making my report upon work performed during the year 1906 upon the Alturas-Cedarville Road, will say that I shall be as brief as possible, realizing that a lengthy document is entirely unnecessary.

We commenced work about 500 feet from the summit of Cedar Pass at a point on the old road (or rather the road completed last year), by making a preliminary



ALTURAS AND CEDARVILLE ROAD. SHOWING LAVA ROCK CUT ON IMPROVEMENT WORK.

survey to Stough's ranch, a distance of 8,000 feet. We found we could easily make a six per cent grade. Consequently, on the 15th of June we made a camp near the work at "Cressler's Cabin," and on the 18th commenced work in earnest with a crew of seven men and four horses. Finding it almost impossible to obtain men at any price, was compelled to make an advance of a little more than ten per cent over last year's rates. Our force was soon increased to sixteen men and sixteen horses, but even with this number of men we could make but slow progress, owing to the extreme unsettled state of the weather, which was very cold and wet.

Our first work was clearing away the brush and timber (after having made a final location of the road), and that we found very slow and laborious, especially removing the timber, as it was very heavy and dense.

Later on it was found necessary to dismiss several of the men, as they thought they were being worked too hard, having the idea in their heads that as this was public work they ought to have a sort of picnic, and because they were compelled to put in eight hours per day on the work (which did not include their going and coming to and from the camp), some made it quite unpleasant for the entire crew, consequently the change referred to was made.

The entire distance of the new grade (called by all "the Stough Grade") is 8,050 feet, as against 4,960 feet by the old road. We moved in that distance something over 13,629 yards, which includes a fill of 1,777 yards over a small ravine. The work was done principally with plows and road grader, although we were forced to do some blasting and resort to the use of pick and shovel. The heaviest work was the fill already referred to, which was over a stone culvert in said ravine.

Great difficulty was encountered in procuring rock that was suitable for the culvert, and for the walls for the fill—for we ripped the fill. We made one bridge over a small stream, the same being as follows: Roadway, 40 feet wide; length of bridge, 12 feet, with necessary approaches, which made a fill of an average of 60 feet in length and 8 feet in depth. We worked through 450 feet of porphyry, which required the use of two hundred and seventy pounds of dynamite; this work, however, was not heavy, but very tedious, owing to the condition of the rock, which seemed shattered in every direction.

When the size of the crew is considered and the conditions we had to contend with, the undersigned thinks the work done (which is of the best and shows for itself) is a good job and was executed very cheaply.

We also finished the work (which was commenced last year) at Stockdale slough, near Alturas—being a distance of a little over 300 feet. This work consisted of making two rock walls averaging 3 feet in height, and covering the old road with rock, then covering that with 10 inches of gravel. A heavy fill was made on "the lane" (as it is called) of a distance of 250 feet in length, by 6 feet in depth, with a roadway on top of 16 feet in width. This was easily accomplished, as the gravel was close to the work.

Great credit is due W. H. McCormick, of Eagleville, the foreman, who not only acted in the aforesaid capacity, but as blacksmith also; oftentimes he was forced to drive a team, fill scrapers, and work on the dump, always holding himself ready, night or day, Sundays or any other time, to fill any place required of any of the men. Much of the time he did all the blasting, not feeling warranted in hiring an expert in that business.

Respectfully submitted.

(Signed) H. S. SMITH,
Superintendent of Improvements, Alturas and Cedarville Road.

KINGS RIVER CANON ROAD.

Although the Act making the appropriation for the survey and construction of the Kings River Cañon Road was passed by the Legislature of 1905, the same did not become available until June 1, 1906.

During the year 1905, after the passage of the Act, a party was formed in Fresno County to visit the cañon, and the Commissioners

under the law, consisting of the Governor and the State Highway Commissioner, were invited to make the trip. Accordingly on July 10, 1905, the party proceeded from Fresno to Millwood and from there to the cañon. Taking advantage of this excellent opportunity to gain some practical ideas of the country through which the road was proposed, Mr. J. S. Eastwood, a deputy county surveyor and engineer, and myself, undertook to obtain preliminary data that we might offer some suggestions from our personal observations. We visited many places likely to be on the various routes, and upon our return reported our conclusions to the head of the commission, the Governor. Therefore, herewith is given the report as describing fully the results of our investigations:

REPORT ON KINGS RIVER CANON ROAD.

SACRAMENTO, CAL., August 4, 1905.

To HON. GEORGE C. PARDEE, *Governor of California*, and
THE HONORABLE BOARD OF SUPERVISORS OF FRESNO COUNTY.

GENTLEMEN: By reason of the law passed by the Legislature of California during the session of 1905, which appropriated funds for the construction, in coöperation with Fresno County, of a wagon road from the General Grant National Park, in Fresno County, in an easterly direction to and into the Kings River Cañon, there was a party formed at the City of Fresno, July 10, 1905, which proceeded to Millwood by stage and then by saddle animals to the objective point in the cañon.

Under the law, the Governor of California and the Commissioner of Highways were constituted a commission to locate, survey, and construct the road above mentioned. Through illness in the Governor's family he was compelled to forego the trip, but the Commissioner of Highways, representing the State and the commission, and Mr. J. S. Eastwood, a civil engineer, representing the County of Fresno, preliminarily inspected and examined the probable routes into the cañon, and herewith place before your honorable body the conclusions and deductions arrived at.

We visited the South Fork of the Kings River Cañon, Bubb's Cañon, and went as far as the Kearsarge Pass between Fresno and Inyo counties. The unanimity of opinion in the party of which we were part was very strongly for opening this grand and magnificent scenery to the public by a more convenient means of traveling to the floor of the main cañon than now exists. We unhesitatingly recommend that this beautiful mountain scenery be connected with the San Joaquin Valley by the proposed wagon road, and think the plan of coöperation of State and county in the construction of such a thoroughfare excellent.

Outside of the places visited we viewed from the distance but a very small portion of the Tehipite section, but have every assurance for believing that in its extraordinarily fine views there is supplementary reason for this needed road.

Aside from our general observations, we examined, as well as our limited time would permit, the routes leading from or near the General Grant National Park to the cañon, and in connection with the U. S. Geological Survey maps in our possession endeavored to obtain the leading features of the country preliminary to a road location. We traveled the trails quite thoroughly, noted the road in the park and made long trips on foot to determine the practicability of a road. The survey made by the present County Surveyor of Fresno County, Mr. McKay, was viewed almost its entire length from the park to the saddle or dip in the ridge just west of Redwood Creek. From the mouth of Boulder Creek to the flat near the Cedar House we traversed the bed of the main cañon on foot, while from the mouth of Boulder Creek, westerly, we thoroughly acquainted ourselves with the country as far as the mouth of Ten-Mile Creek. We crossed Boulder Creek and noted its

ruggedness near the trail. Mr. Ellery inspected the ridge leading into the cañon from near Lookout Peak, near Summit Meadows. This was along the preliminary survey of the former County Surveyor, Mr. G. L. Hoxie, and consisted in that part where he dropped from the high ridge near Horse Corral meadows to the floor of the cañon. These trips, in connection with a general view of the country and the limitations given in the statute appropriating money for the construction of the road, led us to conclude as follows:

1. A road constructed under this law must have the General Grant National Park as a terminus.

2. The location must be in Fresno County, if said county is to furnish money to aid in construction and to maintain it.

3. The location must be such as to give the longest period of service during the season.

4. It must be so located as to give the greatest benefit to the public in giving access to the main and best scenery.

5. It must be so located as to make a permanent road for the least first cost possible, consistent with good and inexpensive maintenance.

Fully considering all of these points in the determination of the best route, it will be found that the beginning should be at the end of a wagon road built through the General Grant National Park to the northeast gate, a short distance from the summit of the divide which must be crossed, then ascending this ridge and crossing it, whence the line should descend the drainage basin of the Ten-Mile Creek to a point near the end of a road now terminating on Ten-Mile Creek. This distance must be covered in a manner that will permit of a good grade, and therefore its particular line would be left to the work of survey. From this point it would run down the right bank of Ten-Mile Creek on the most advantageous ground, gradually descending to the South Fork of the Kings River just below the lower one of the three limestone points named Windy Cliff by the Geological Survey; thence up the South Fork to a point nearly opposite Grizzly Creek, where the river is to be crossed and the line continued on comparatively flat ground as far as may be required.

By this route, the road will contain no adverse grades from the first ridge east of the park to the river. The drop in elevation from this ridge to the previously mentioned point on Ten-Mile Creek is 2,200 feet, requiring 6.6 miles of road at six per cent to make the descent. From the Ten-Mile point to the South Fork of the Kings River the difference in elevation is 1,700 feet, requiring, with flattened grade at some rough points, 6 miles of road to bring the line within one mile of Boulder Creek. Thence up the river along the talus earth and rock of the south side on the grade of the stream, which is 100 feet per mile, about 8 miles to the open valley, or beginning of the floor.

Allowing for curvature, the road should be about 7 miles from the park ridge to the Ten-Mile Creek; with the additional mile from park to the top of divide, making 8 miles to the point where the McKay survey diverts. From here to the river proper is another 7 miles, and along the river to the open valley 8 miles. In all, the total distance from the park line to the west end of the floor of the valley proper is 23 or 24 miles.

This route best complies with the conditions named above as prime requisites for the location. Not only will it give an excellent grade from the park to the cañon, but it will form a central line from which roads or trails may be built to points of interest. The Tehipite Cañon may be readily reached by trail. The big trees in the small cañons to the south will be of easy access, and the great rocks and cliffs of the cañon along the road line will be no small item of interest. In fact, such a road will open a part of the Sierra Nevada Mountains of exceeding and unusual beauty. To within about five miles of the river on this route the line would run through timber, after which brush will be encountered until the river is reached, when along the river brush and timber intermingle.

From the examination made by us without actual survey data it appears that the line of road for the first 15 miles will cost not over \$1,350 per mile, or about \$20,000; while the last 8 miles will cost approximately \$25,000. Any other route on the character of ground such as this line would traverse for the first 15 miles,

could not be constructed for less than an average of \$1,350 per mile, so that if the distance be increased by grades in and out of the depressions by a route farther to the south the first cost is but slightly less and the maintenance greater, due to the erosive power of water on a grade.

To locate a road so that it is to cross the deep depressions of the drainage courses is, as written before, but to add distance for the purpose of getting into and out of these depressions, and hence it must be located either below them entirely, as is proposed, or above the heads of the streams which form them. As it is impossible to head these streams and remain inside the boundaries of Fresno County, the only route besides the one chosen must cross the intervening divides of Ten-Mile and Boulder creeks, and these ascensions and descensions require distance to give a proper grade. This route will of necessity start from the same pass or saddle in the divide east of the park and be identical to that point, descending from this point to a crossing of Ten-Mile Creek, on which the highest point possible in Fresno County is 6,000 feet, a drop of 1,200 feet from the saddle to Ten-Mile crossing; thence the road must ascend the divide between Ten-Mile and Boulder, a rise of 1,600 feet, the lowest point being 7,600 feet; thence descending to Boulder Creek, which must be crossed at an altitude of 6,500 feet, a drop of 1,100 feet; thence ascending to the pass above Horse Corral meadows, the lowest point of which is 7,600 feet, a rise of 1,100 feet; thence descending to Kings River Cañon via Lightning Creek, a descent of 3,000 feet, to the floor of the valley at the Cedar Grove Hotel, altitude 4,600 feet.

Thus to reach the cañon adverse grades to the extent of 2,700 feet must be overcome, and these in turn make it necessary to build 29 miles of road to overcome them, not counting road necessary to avoid difficult points of rock, etc. On a return trip from the cañon the adverse grades would be 5,300 feet.

An intermediate route is of course out of the question, as it would need to cross ridges and depressions at even greater differences of level.

In the compilation of the foregoing data we have consulted in connection with the field reconnaissance the topographic maps of the U. S. Geological Survey.

Therefore, so far as our examination goes, we recommend the lower route as outlined as the only route in Fresno County that can in a degree of economy comply with the terms of the Act making the appropriation.

All matters and deductions herewith presented are merely preliminary, and we submit the same from that standpoint. As we have principally dealt with the engineering features for the road, we offer for consideration this report to the Hon. George C. Pardee, Governor of California, the leading member of the commission for the construction of this important work, and your honorable body.

Respectfully,

(Signed) JOHN S. EASTWOOD,
Deputy County Surveyor of Fresno.

(Signed) N. ELLERY,
State Highway Commissioner.

By the terms of the Act it became necessary to obtain from Fresno County an appropriation of \$12,500 to make the State appropriation available. Therefore, Mr. A. M. Drew, who deserves much of the credit of the success of the work to date, and myself, appeared before the Board of Supervisors of Fresno County and, after stating plainly the position of the State in the matter, the Board passed the following resolution:

FRESNO, CAL., May 10, 1906.

Office of the Board of Supervisors of Fresno County, California.
Present, full board.

W. O. Miles, Clerk. By A. D. Ewing, Deputy.

In the matter of allowing claims for the Kings River Cañon Road.

Resolved, That it is the sense of the Board of Supervisors that the bills of the State Commission for the construction of a public road into Kings River Cañon be

allowed and paid to the amount of one third of each bill presented to two thirds paid by the State of California, the amount so appropriated in no case to exceed the sum of \$12,500, work to commence on or after June 1, 1906; said amounts to be expended under the direction of the Board of Supervisors of Fresno County and the State Commission.

The above resolution was passed by the following vote Ayes—Supervisors Burleigh, Mitchell, Beall, Johnson, and Martin. Noes—None. Absent—None.

Attest: A true copy of resolution.

W. O. MILES,
County Clerk and ex-officio
Clerk of the Board of Supervisors.
By A. D. EWING, Deputy.

As all preliminary business incident to the beginning of work had been completed, a surveying party was placed in the field, the first camp being pitched at Huckleberry Meadow near the General Grant National Park. The park being one of the statutory termini of the route, work was commenced July 4, 1906, at the northeast park gate in extension of a good park road. The party consisted of Mr. E. B. Henderson, engineer in charge; W. W. Wooldridge, levelman; F. Pendergast, rodman; J. F. Clewe, cross sections; R. McKee, assistant to Mr. Clewe; R. Bell, head chainman; C. Barnum, rear chainman; A. Drew, transit rodman; M. Blum, stakeman, and C. C. and W. Wood, axmen. The survey was started under my personal supervision, but after getting the work under way I was compelled to leave camp on other business. During my absence, until September 7, 1906, camp was changed once to Ten-Mile Creek, and the survey in that time extended from the northeast gate of the General Grant National Park, on a very easy rising grade, to the summit of the divide near the head of Indian Basin. At this point, about two miles from the starting point, the divide was crossed in a sag and the survey continued along the north slope of a ridge extending toward Ten-Mile Creek until by a gradual descent Ten-Mile Creek was crossed at $9\frac{1}{4}$ miles. A very large proportion of the route is over earth, with perhaps in the foregoing distance $11\frac{1}{2}$ miles of solid rock or boulders, which does not present any difficulties of construction. After crossing Ten-Mile Creek the line was run around by and crossed Tornado Creek, from whence it continued toward the cañon of the South Fork of the Kings River. Upon my arrival in camp, September 7, 1906, two miles of survey had been made beyond Ten-Mile Crossing, thus making an excessive walk for the help. Consequently, the following Sunday, September 9, 1906, camp was removed to Redwood Creek, and I assumed personal charge of the work. We continued the work with the crew reduced by four men, to the ridge known as Horseshoe Bend, where, at the distance of $20\frac{1}{4}$ miles, near Windy Cliffs, work was suspended, on account of the long distance from camp, until next year. In the country traversed perhaps the most difficult of construction is between Lockwood Creek and Redwood Creek, where considerable solid and loose rock could not

be avoided. After crossing Redwood Creek, however, the ground was good, so that the line was switched back for two complete turns to get down to the river, and on to the Horseshoe Bend ridge. The route selected under the provisions of the statute will clearly make the finest scenic road in the whole State. The purpose of the road was to open up the great Kings River Cañon, and by the line now partly surveyed there will be no greater pleasure road.

EEL RIVER IMPROVEMENT WORK.

From the survey made of Eel River during 1903, by this Department, it was seen, and so recommended, that to save the friable alluvium deposit banks, revetment must be resorted to. This plan, however, was changed somewhat by legislative action during 1905, and money was appropriated to build jetties for the rectification of Eel River channel above the town of Fortuna. Accordingly during July 1 to 6, 1905, a local survey was made locating the work, and during that month plans and specifications were drawn with the sole idea of best subserving the interests involved, with the available fund of \$40,000. On August 1, 1905, an advertisement was inserted in a Sacramento daily newspaper calling for bids for the work, with the result that only two bids were received and they were from Humboldt County firms.

Proposals.

	Humboldt Contracting Co.	Mercer-Hodgson Improvement Co.
Rock in finished work, per ton, east side	\$3 75	\$3 50
Rock in finished work, per ton, west side	4 75	4 50
Loose brush in finished work, per cord	5 00	5 00
Piles in finished work, each	18 00	20 00
Grading down banks, per cubic yard	30	25
Barbed wire entangled in finished work, per 100 lbs.	7 00	6 50

Both bids appearing too high they were rejected and it was determined to again advertise, in an endeavor to reduce the cost of work. The amount of constructive work outlined in the plans would, under the figures, cost very close to \$80,000. Following the second advertisement, five bids were received, and the lowest, that of the Atlantic, Gulf and Pacific Company, reduced the cost price to \$43,000 for the amount of work outlined:

Bids.

Firms.	Rock East Side, per Ton.	Rock West Side, per Ton.	Concrete, per Yard.	Brush, per Cord.	Piles, Each.	Grad- ing, per Yard.	Wire, per 100 Pounds.
Jenkins & Wells			\$4 75	\$3 50	\$13 00	\$0 20	\$7 50
Healy, Tibbitts & Co.	\$2 85	\$3 75	3 75	5 90	17 40	25	4 60
Mercer-Hodgson Improve- ment Co.	4 25	4 75	10 80	5 00	20 00	25	7 00
Atlantic, Gulf and Pacific Co.			2 25	4 50	10 00	25	7 00
Humboldt Contracting Co.	3 50	4 40	4 15	4 90	16 00	25	6 10



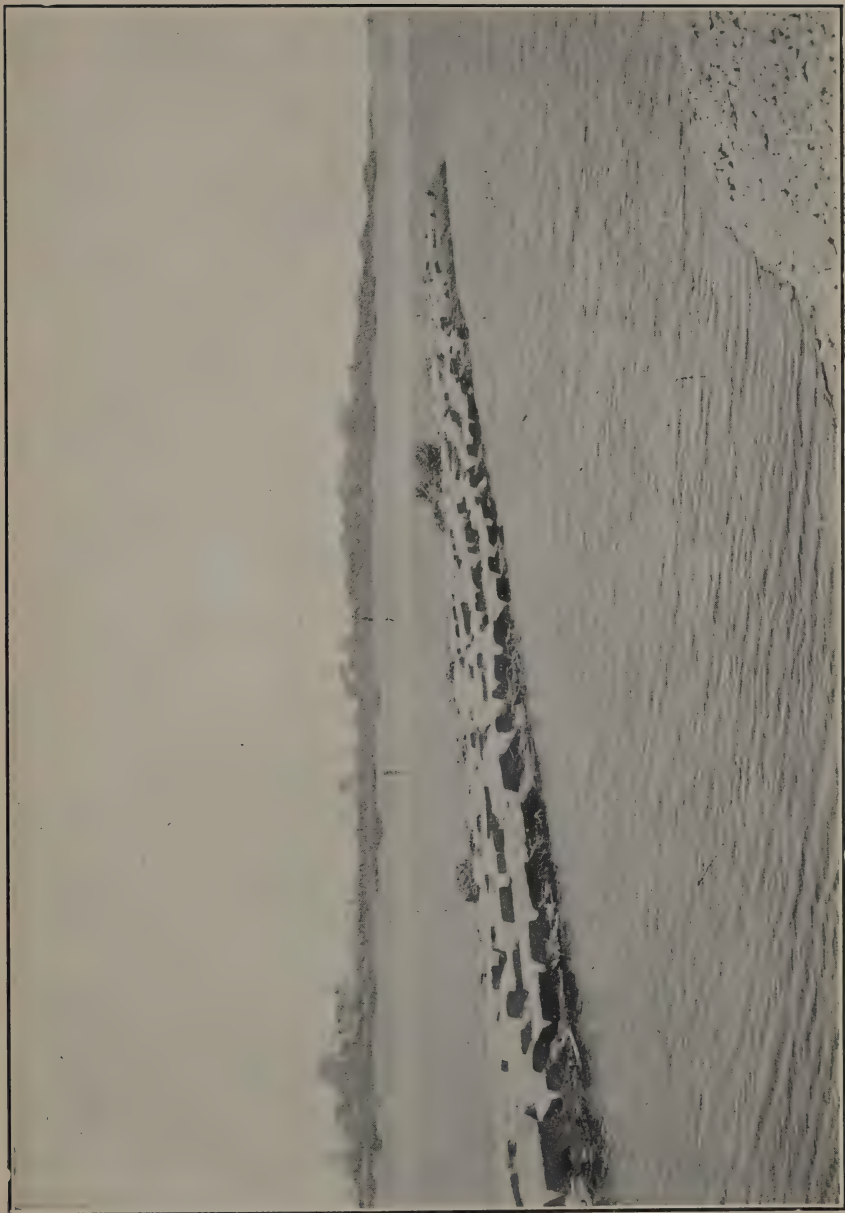
EEL RIVER IMPROVEMENT WORK. SHOWING BANK SLOPE FOR
REVTMENT WORK.



EEL RIVER IMPROVEMENT WORK. SHOWING PILES FOR JETTY WORK.



EEL RIVER PROTECTION. BANK SHOWING WILLOW BRUSH GROWING.



EEL RIVER PROTECTION, EAST JETTY.

The bid of the Atlantic, Gulf and Pacific Company, as given in the above table, was accepted and that firm given the contract. They began work September 25, 1905, and continued through the fall and winter until January 7, 1906. In this period they built the east jetty of 450 feet, and 1,000 feet of protecting revetment, but did not weight this jetty with sufficient concrete for completion. On the west jetty of 700 feet they failed, on account of high water, to place concrete blocks upon it until later. The revetment of 1,100 feet was completed and in good order for the winter waters, but the point of the west jetty which was severely exposed to the full impact of the stream was damaged 200 feet in length; the remainder, however, remained intact and gave good results.

During the latter part of January and early in February, 1906, under the company's agent and myself, 500 feet of rough revetment was built below the east jetty and 700 feet of rough revetment built below the west jetty. In each case the purpose of this work was to prevent the eddy from taking away the bank immediately below the jetties. For 500 feet of the west jetty we placed concrete blocks, that it might be weighted and hold against the heavy floods.

Thus the work was left in an incomplete shape and it withstood the biggest water known in Eel River, with no damage to it where fairly weighted. During 1906, the contractor began work on August 20 and completed the contract November 9, 1906. The work was done in a satisfactory manner, and gives to the State good, substantial river improvement, the effect of which will be felt as time goes by. In the revetment work the banks were protected and must necessarily operate the first winter if anything is to be accomplished, but with low jetties such as constructed in Eel River, at least three or four years must elapse before the full benefits can accrue. When, however, the willow brush used in the construction gets a good heavy growth, then the effective plane of the jetties will be raised. By inspection of the west jetty, after one year's time, it was found that the original plan of having the willows grow and do their work was being finely realized. For 400 feet on the jetty, willows without interruption grow nearly five feet high and in time will present a veritable barrier, giving the relief sought.

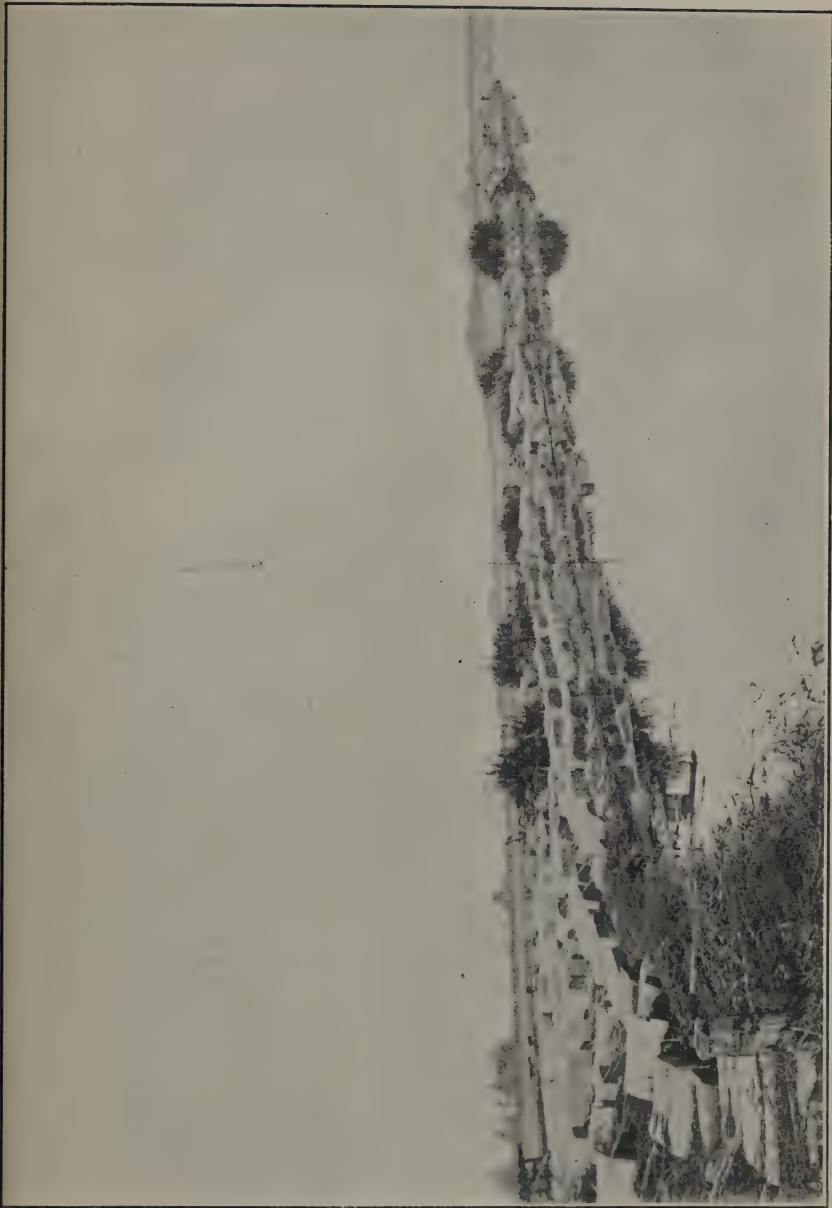
Numerous property owners in the vicinity of the east jetty can not comprehend the value of the jetties, and as in all cases where technical work requires time to accomplish its end, their understanding of the working out of the plan is not clear. Perhaps the best illustration of this was shown in the fact that ninety-nine per cent of the people viewing the jetties offered the remark that one might as well place toothpicks in the stream. Note the change of sentiment when both jetties not only remained intact while incomplete, but solidified by fine

deposits in and about them. With the revetment work along the banks, results are immediately seen. Willows for the whole length of such work are seen growing at least four feet in height, making, with the wire, an impregnable mass against the water.

It may not be amiss to state the manner of constructing this work, so a short, detailed account is given: Beginning with the almost vertical banks, they were sloped back to about 30 degrees from the water's edge. Then every 25 feet along the water were driven piles, although concrete was preferable but not obtainable at the time, and between them were stretched five strands of barbed wire. On the top of the bank concrete blocks were similarly set, with four strands of barbed wire connecting them. To these two lengths of wires were stretched, two strands every four feet up and down, along the bank. Every 8 feet was attached wire for lacing, after the brush had been laid, when two top wires were drawn over the 24 inches of brush and drawn down by the lacing, thereby creating a mattress. The brush was composed of at least forty per cent willow and was weighted with six inches of gravel to hold it and give opportunity for growth. This completed the revetment scheme, which has worked admirably and has already been an educator to those desiring bank protection.

The jetties were constructed by driving two rows of piles 12 feet apart with 12 feet spacing; then filling in a layer of brush 35 feet wide on the base and 5 feet thick. Upon this was deposited a foot of gravel—the whole brush being securely wired to the piling, and again a layer of brush 4 feet thick and about 27 feet wide. Gravel was used to weight down this second layer, and upon it was placed concrete blocks varying in size from 8 to 20 cubic feet. Through these blocks run three strands of barbed wire, connecting the blocks and piles together. This plan gives very substantial results against a river that runs, when at its high stage, 12 miles per hour, is about 30 feet deep, and one half mile wide. Besides this torrent of water, redwood trees of two hundred tons' estimated weight travel these waters, bumping everything in their course.

In addition to the \$32,000 appropriated by the State, the citizens raised the \$8,000 required of them by the statute for the work, and \$1,953 for weiring some sloughs below the west jetty. To this \$1,953, the county added \$1,900 and this Department, for the State, added \$1,000. With this sum three weirs were built under my supervision, as a check to the water entering the head of Salt River and practically in conjunction with the jetty. On the east side the county is now engaged in roughly reveting the bank below the east jetty, and have done about 2,000 feet on a low bank. This work was placed under the supervision of the County Surveyor and this Department, and protects for the above distance a county road along the river bank. To



EEL RIVER PROTECTION. WEST JETTY, 700 FEET LONG. WILLOW STARTING GROWTH.

assist in this work this Department donated some Standard cement, in sacks, for concrete. For this material to go through this winter in the damp atmosphere of that country would ruin it.

Upon completing the contract it was found that the inspector in charge of the work had overrun the appropriation by \$1,241.22 in order to get both jetties completed. This sum, however, can be reduced by a shipment of cement bags, which should bring \$450, and some barrel cement on hand worth \$250, leaving a balance due of \$541.22. Therefore, it is recommended such deficiency be appropriated to complete settlement with the Atlantic, Gulf and Pacific Company of San Francisco.

It is further expressly recommended that the Legislature appropriate about \$5,000 to care for and remedy any damage done the improvement work on Eel River.

GUIDEPOSTS FOR THE DESERT SECTIONS OF CALIFORNIA.

Under the law providing for guideposts in the desert sections of California, an advertisement was inserted in the *San Francisco Chronicle*, August 3, 1905, inviting proposals on guideposts. In response there were received, on August 12, 1905, five bids in the following sums:

The Schaw-Batcher Company, each post complete.....	\$7 50
Pacific Sign and Enameling Company, each post complete.....	8 75
Judson Manufacturing Company, each post complete.....	11 10
Wiet-Gæthe Company, each post complete.....	8 23
Jenkins & Wells.....	6 25

These bids were received under the specifications given in the appendix, and upon the bid of \$6.25 per post complete, being the lowest, the contract was awarded Jenkins & Wells.

Numerous communications were exchanged with the Boards of Supervisors of the counties enumerated in the statute, with the result that the following posts were shipped:

Inyo County—January 3, 1906, per J. A. McKenzie, Keeler, 100 posts, 152 sign-boards.

Riverside County—March 10, 1906, per W. V. Covington, Mecca, 36 posts, complete.

Kern County—March 14, 1906, per H. A. Jastro, Bakersfield, 28 posts complete.

Los Angeles County—June 5, 1906, per W. C. Patterson, Los Angeles, 20 posts, complete.

San Bernardino County—July 17, 1906, per J. H. West, 130 posts complete. Daggett, 30; Needles, 50; Victorville, 25; Barnwell, 25.

Ventura County—No posts wanted.

San Diego County—No posts wanted.

The locations of these posts as yet have been returned from only Inyo and Riverside counties.

CONTINGENT APPROPRIATION.

In 1905 the traveling and contingent appropriation of this Department was increased to \$500 per annum. This is inadequate for the purposes intended. The necessary traveling in connection with the work of the State costs considerably more than this appropriation, so if there is to be any collection of data relating to this office, it seems that the recommended appropriation of \$750 per annum in 1905 should be allowed for the traveling and contingent expenses of this office.

MISCELLANEOUS WORK OF THE DEPARTMENT.

In the past two years this Department has been called upon to give advice relative to, and undertake in some cases, county or outside State work. Through requests from the Hon. F. W. Hatch, Superintendent of State Hospitals, I have located sewer and water lines at the Home for Feeble-Minded Children, at Eldridge, and assisted generally in matters of engineering before the Board of Managers of that institution.

Upon request from the Supervisors of Siskiyou County, I visited Yreka and inspected a route into Little Shasta Valley, that county, for a macadam road. It was over adobe soil, of difficult construction, so that we carefully went over the whole scheme to be sure of success in the venture.

After the earthquake in California, through Hon. A. J. Pillsbury, and Hon. F. W. Hatch of the Lunacy Commission, I was requested to visit, in company with Mr. Pillsbury, the State Hospitals and especially damaged State buildings and report on their condition. The following report was submitted:

SACRAMENTO, CAL., June 5, 1906.

To HON. GEORGE C. PARDEE, Governor of California.

SIR: In compliance with the request of Mr. A. J. Pillsbury, Secretary of the State Board of Examiners, and also that of Dr. F. W. Hatch, Superintendent of State Hospitals, for an examination of the injured and wrecked State buildings damaged on April 18, 1906, I herewith present you with the ascertained facts and some very essential conclusions drawn from such findings. In the light of the very great damage sustained by the State in its buildings, I shall take up in detail the constructive failures and endeavor to make clear the State building situation as now existing.

On May 31, 1906, I visited the State Normal School buildings at San José. The foundation of the main brick building was carefully examined and found unimpaired in the strength existing before the earthquake force destroyed the upper part or superstructure. The fractured walls do not reach into the foundation sufficiently to render them unsuitable for some uses, but the construction used therein is poor. All the mortar binding the bricks together is very weak and does not cover them sufficiently on the inner part of the walls to make a thoroughly good, substantial base. This practice of not completely surrounding each brick with mortar weakens the wall just in the proportion of the voids in the wall. The lateral or horizontal strength of a brick structure depends very largely upon the adhesion

between mortar and brick, so that where such is not complete, shocks or forces acting horizontally are very destructive.

The floors in the main brick building have been generally loosened from their supports by the walls becoming separated through fractures or cracks in the brick-work. Where windows or doors cut the walls, making weak lines in the building, fractures occur from the top to the foundation, thus entirely destroying the strength and bond of the building.

In the matter of patch work in reconstruction, I thoroughly recommend against such practice, as the walls would necessarily be replaced along all the cracks, thus practically giving new walls with the defective and weak places between the new work, meaning that the resistant strength of the building is not much enhanced thereby. It is my earnest belief that a completely new structure should be built of either reinforced concrete or steel, so we may, as thoroughly as possible, safeguard against horizontal forces or sudden shocks.

In its present condition it is dangerous to life and should be summarily condemned.

My examination of the wooden building connected with the main brick building by a corridor revealed the foundation and walls intact. The only damage found was the general cracking and shaking down of the plaster.

From the Normal School I visited the Agnews State Hospital the following day, June 1st. Here the destruction was complete, leaving no work of any value, except perhaps, a very small brick shed or two, and a foundation of one of the cottages constructed, I am told by the Superintendent, by the patient labor. In the main building I found very serious defects in the construction. The mortar was very weak and the walls full of voids occasioned by a lack of mortar. The main building foundation is shattered thoroughly and so weakened as to be of no value for future construction. The same condition of mortar exists in this base, so that should there be no fractures at all it is very dubious if it have any value. Surely for a good, strong modern building of two stories or over it would be such a weak point as to make the whole building unsafe. There is absolutely no economy in weak base or foundation construction, and I therefore recommend strongly against its use.

Only a glance at the upper work or superstructure will convince one of its entire uselessness. Aside from the danger to life at the time of the earthquake, it would have been far better had the whole thing been razed to the ground. It was in this superstructure that I found a most serious and defective construction, and had it been more in line with the bare necessary strength employed in engineering, I think there is no question that a great many of the 112 lives lost might have been saved. The floor joists had a bearing of about two inches in the brick wall and were very insecurely anchored to the walls by iron rods of one to every twelve joists. These rods were held in the wall by one width of brick of four inches, so that the strength value was practically *nil*. Had the joists been given good structural bearing on a base of nearly the whole wall and been well rodded to the brick work every four feet with rods extending through the wall, and had bearing plates, thereby creating as much lateral strength as that form of building could have, instead of the walls crashing in upon inmates and officers of the institution, most of them would have fallen in the line of least resistance—outward. This is exemplified at the Feeble-Minded Home at Glen Ellen, where the floors held and in almost every instance the great number of walls that fell were precipitated outward, with not a single loss of life. The tower of the main building was in such a mass of ruins as to be of little value for examination for strength, therefore I cannot exactly determine its cause of failure without further investigation. All walls are either fractured or shattered completely, with absolutely no value other than the contained brick and casings of windows and doors.

On June 2d, the State Hospital at Ukiah was thoroughly examined and found to be seriously damaged. The steel tower built in and above the administration building so vibrated as to fracture all the walls to such an extent as to render them unfit for use as component parts of the building. The cracks in this building go to the foundation. Here again is found defective mortar and mortar voids in the walls,

and also an additional weak foundation, showing in places perceptible settlement. Here also is exemplified the value of a composite structure that failed by lack of uniformity of strength against lateral forces or severe shocks. The vibration of the tall steel tower was not equally taken up by the brick masonry, so that numerous cracks were made, rending the building to its foundation, to such an extent that it must completely come down if a secure and permanent building is desired. The other brick structures at this institution revealed some cracks which greatly weaken them, but as they are practically distinct and separate in construction, with foundation in good shape, they can be reinforced with rods and repaired along the fractures without the loss of the building.

In the ornamental peaks or towers surmounting the building were placed water tanks for water storage. These in all cases examined were found to be very destructive to the building, and at the State Hospital at Ukiah should be discontinued in the use of the water supply. Wherever tanks for storage purposes are required it is recommended that they be separated in some construction of their own, at a suitable and safe distance from all buildings. One tower thus containing a tank with water was badly shattered, and it will be necessary to take it down to the roof. The power chimney was found to be badly cracked a short height above its base. However, this can be remedied by re-setting the brickwork and then surrounding the chimney with a reinforced concrete jacket, at least to the top of the building adjoining.

At Eldridge, the Home for Feeble-Minded received severe damage. Practically all the brick gable ends of the main building were cracked off at the floor line and fell outward. Nearly all ornamentation was precipitated to the ground and the two main ends of the building are badly cracked to the foundation, necessitating rebuilding. Other cracks in the walls in about ten places run down to about the first story, while the foundation, of plain concrete, is in good shape. This building can be replaced to its former dimensions with considerable work, and I believe with good and frequent tie rods, can be restored practically to its former usefulness and strength.

Poor work is found at all points in the brick walls. In places there are exposed vertical joints in such walls where no mortar binding existed for lengths of at least six feet. Again, poor mortar was used, so that the whole structure, even without fractures, was weak.

The Manse, a low brick building of one story, was cracked in a number of places from top to bottom. A wall at the side of a water tank in the rear of the building fell out. This structure, on account of its very low height, can be quite easily repaired.

Two new structures, the hospital and a one-story cottage, were practically uninjured. A few ornaments fell from the peaks, and in the cottage one crack runs from the roof to the base of a window.

Numerous chimneys fell on the main building and Manse, where the slate roofs were damaged locally, although not seriously.

At this institution the plastering is generally destroyed and will necessitate complete replastering.

From Eldridge I went to the Napa State Hospital and on June 4th examined the buildings composing that institution. Here I found the best work and the least damage. The front tower was partially wrecked. As it is built more consistent in materials with the other nearby parts of the building, the damage reached a far less extent than at the Ukiah Hospital. About seven distinct cracks occurred in the outside walls at or near the corners of wings or extensions. They extend from the roof to near the lower windows, where they can not be traced farther.

The foundation of the main building was thoroughly inspected inside and outside, showing a solid, firm base, of good work. It is well battered (that is, slanted on the outside), deep and heavy, giving a substantial bearing area, with no signs of failure. Generally the exterior walls are in good condition, and especially those in the rear of the building, where few openings occur, are true to their original construction.

It was at this institution I found the best mortar. Some is of cement and lime, while in other places excellent cement mortar of good strength and complete adherence to the bricks is found. But in few places were mortar voids located, so that on the whole Napa Hospital remains a substantial structure, and when repaired at the fractures will stand comparatively well against shocks or lateral force.

From my examination of the foregoing buildings I am able to formulate some conclusions which I think should be adhered to in future constructive work, and in the way of improvement offer some suggestions as to future building materials.

Beyond any doubt great care must be exercised in the reparation of all buildings not so damaged as to necessitate their complete reconstruction. All brickwork should be thoroughly bonded with nothing but cement mortar of good quality, and all work should be so tied with iron or steel as to give it the greatest security against shocks. The floor system should be so well tied to the walls as to brace them thoroughly and be of value as a lateral resistant. Tanks used for water storage should be discontinued in use or taken out of the buildings. The composition of the building material should be as uniform as possible. No towers should be used, unless made an integral part of the building, and then only when figured for their proper stability; and in no case should an important building of over two stories be on a brick foundation, but of reinforced concrete, that the walls may be bolted or fastened to the base.

In the face of the present destruction to the State institutions, it appears that good substantial steel or reinforced concrete buildings should be erected wherever necessity requires over two-story structures, and that the materials used therein should be of the best quality. Honest workmanship and superintendence are absolute requirements, if we are to get good and lasting results.

Respectfully,

N. ELLERY,

Engineer and Highway Commissioner.

During 1906 I attended a road meeting at Yuba City and inspected very generally the methods of road oiling, in an endeavor to gain the knowledge necessary to the successful application of oil to roads.

REPORT OF LAKE TAHOE WAGON ROAD COMMISSIONER.

ARTHUR S. LYON, COMMISSIONER.

SMITH FLAT, CAL., November 1, 1906.

*To His Excellency, GEORGE C. PARDEE,
Governor of the State of California.*

SIR: I have the honor to submit to you my biennial report of matters pertaining to the Lake Tahoe Wagon Road, which is situated wholly in El Dorado County, beginning about half a mile east of Smith Flat and running sixty miles easterly to the State line at Lakeside Park.

The Legislature, at its session of 1905, appropriated \$9,200 for salary and maintenance of this State road for two years from July 1, 1905; besides this it appropriated \$6,000 for the purpose of building two permanent bridges, one at Oglesby Cañon, between the twentieth and twenty-first mileposts, and one over Trout Creek, in Lake Valley, within about four miles of the terminus of this State road.

In August, 1905, a contract was let to T. E. Clark of Sacramento, under specifications drawn by the Hon. N. Ellery, State Highway Commissioner, for a reinforced concrete bridge or culvert, for the sum total of \$871 for all concrete work, and to which there was an additional expense of \$706.25 for survey, inspection, and filling (which was made from hard, rocky soil on both sides), making a total cost of \$1,577.25, which, owing to the nature of the place and the sharp curve which had to be eliminated, I consider a very reasonable figure.

Under plans drawn by the State Highway Commissioner, I commenced work on Trout Creek bridge, which is to be a stone arch, on August 28, 1906, and we worked up to October 10, 1906, when we had to stop for this year on account of cold weather. We were able to erect both piers to the spring line, and to get a large quantity of the stone split, which is obtained in close proximity to the work; have also got nearly all the material for finishing stored close by; all at an outlay of \$3,572.40, which leaves a balance of \$851.35 in the special appropriation.

Out of the general maintenance appropriation since my last report on December 1, 1904, I have repaired roadbed by use of scraper, a total of seventy-one days in two years, together with a liberal use of powder and men to remove obstructions; have also put in thirty-four terra

cotta culverts six to eighteen inches in diameter, which cost from \$20 to \$250 apiece, according to the labor required to remove old structures and to get a solid foundation and the length and height of retaining walls to bring the roadbed to its natural grade; also, one 30-inch terra cotta pipe culvert, where it was impossible to get the necessary rock without heavy cost for transportation; also, raised the roadbed about four feet to a natural grade, at a cost of about \$225. I have also put in three stone culverts, well cemented, at an average cost of \$325 each, together with lots of repair work with pick, shovel, and drills, which makes a very decent roadbed, but does not present much gain from year to year, as the first fifteen miles is composed of a light, loose soil, which in summer is very dusty and in winter gets muddy and sticky; the other forty-five miles is a granite formation, with lots of hard ledges and a good many boulders. There are about eight miles of it fairly well turnpiked; the balance has to be closely watched in the fall to prevent it from washing.

During the heavy snow of the past winter, 1905-06, two wooden bridges near the summit on the American River were broken down, and owing to insufficiency of money for permanent work, had to be replaced with wood where rock or concrete would be far better and more lasting.

The past year there has been considerable travel over this road by automobiles, as it is the best outlet for that mode of travel from our neighboring State of Nevada to the coast, where in former years the automobile was an impossibility on these rocky, mountainous roads.

I recommend that the proper authorities see that the general maintenance appropriation be raised to a considerable extent, so that the road can be put and kept in the proper shape for the increased travel that is sure to use this road, both for business purposes and also by those who seek pleasure.

In closing, I wish to extend thanks to your office for the interest you have taken in my work and also to Hon. N. Ellery, State Highway Commissioner, for advice and aid which he has always been in readiness to give toward the improvement and betterment of this highway.

Respectfully submitted.

ARTHUR S. LYON,
Lake Tahoe Wagon Road Commissioner.

APPENDIX A.

SPECIFICATIONS FOR THE CONSTRUCTION OF GRAVELED STREETS, IN THE CITY OF LOS ANGELES.

1. PLANS, ETC.

The work herein provided for is to be done in accordance with the plans, profiles, and cross-sections on file in the office of the City Engineer of the City of Los Angeles, and all work shall, during its progress and on its completion, conform to the lines and levels which may, from time to time, be given by the City Engineer.

2. SUB-GRADE.

Sub-grade for the roadway shall be eight inches, and for cement sidewalks three and one half inches, below the surface of the finished work, unless otherwise shown on the above mentioned plans, profiles or cross-sections.

3. GRADING.

Grading shall include the removal of all earth, stone, loose rock, clay, shale, cement, hardpan, boulders, solid rock, and all other materials that may be encountered in preparing the street, and shall include also all filling, trimming, shaping, picking down, refilling, surfacing, or other work that may be necessary in bringing the surface of the street to the sub-grade or required shape. When mud or other soft material is encountered it shall be taken out and the space filled with good earth or gravel. The contractor, however, shall not be required, in such cases, to excavate the mud or other soft material to a greater depth than two feet below sub-grade.

In places where filling is necessary to bring the street to the required grade, it shall be done with good sound earth. The embankment shall be carried up, of full width, in layers not to exceed one foot in thickness, and the teams shall be made to travel as evenly as possible over the whole surface of each layer, both going and coming. The formation of well-defined ruts is specially prohibited. No material of a spongy nature shall be used for filling. The slopes of embankment shall be two horizontal to one vertical, and shall be trimmed as they are carried up. The space over which fills are to be made shall first be cleared of all brush or timber.

After the block or section has been graded as above specified, the surface shall be rolled, with a roller weighing not less than 250 pounds to the inch width of tire, until the surface is unyielding. Depressions made by rolling shall be leveled up with good earth and again rolled. Such portions of the street that can not be reached by the roller, and all places excavated below sub-grade and refilled, and all pipe trenches and other places that can not be properly compacted by the roller, shall be tamped solid, and in case of wet weather or soft or muddy ground making the use of the roller unsafe or impracticable, the rolling shall not be undertaken until the ground has become sufficiently dry.

The contractor shall notify the superintendent of streets when a block or section has been brought to sub-grade, when the latter will check the elevation of the same, and if the work is found in accordance with the specifications and the grades given, the contractor shall proceed as hereinafter mentioned.

4. SURFACING ROADWAY.

Upon the surface, prepared and brought to sub-grade in the manner above specified, shall be spread in the following described manner: Two layers of good gravel, the bottom layer to have a thickness of five inches and the top layer to have a thickness of three inches, after having been rolled. The first layer, which shall contain no stones larger than two and one half inches in greatest diameter, is to be uniformly spread on the roadway, and well moistened. The gravel shall be well rammed for at least one foot from the gutters, should these be paved, or if the gutters are not paved, then one foot from the curb. The remaining portion of the roadway shall then be rolled with a roller, weighing not less than 250 pounds to the inch width of tire. The rolling of the roadway shall commence at the rammed portion. All depressions must be promptly filled, moistened, and again rolled. The rolling must be continued until the surface will not yield under a roller of the weight above described.

On this surface shall be spread the top layer, which shall be raked free from all stones larger than one inch in greatest diameter. If no gutters are provided, these larger stones shall be raked to the curb and distributed over a strip two feet in width next to the curb. If gutters are provided, then these stones shall be distributed on a strip two feet in width next to the gutter. The top layer of gravel shall then be thoroughly compacted by ramming and rolling in the same manner as specified for the first layer.

Oil shall then be evenly distributed over the entire surface of the roadway in a volume equal to one half ($\frac{1}{2}$) gallon, by measure, per square yard of the street surface.

Clean, sharp sand shall be sprinkled over the entire surface of the roadway until no oil or the residue thereof can be seen.

After a lapse of not less than twelve hours, oil shall again be evenly distributed over the entire surface of the roadway in a volume equal to one half ($\frac{1}{2}$) gallon, by measure, per square yard of the street surface.

The entire surface of the roadway shall again be sprinkled with clean, sharp sand until the oil and the residue thereof is completely absorbed, and then rolled with a roller weighing not less than 250 pounds to the inch width of tire until the surface is unyielding.

The total amount of oil used shall not be less than one gallon per square yard of the street surface. The oil shall be applied at a temperature not less than 150° Fahrenheit.

The oil used shall be crude petroleum and shall answer to the following tests, to wit:

(a) *Specific Gravity.* The specific gravity shall not be lower than 10° nor higher than 11° Baumé.

(b) *Test For Specific Gravity.* All crude petroleum shall be tested for specific gravity, and the gravity thereof shall be determined by the use of "The Westphal Specific Gravity Balance," in conjunction with the accepted scale, hereinafter described, for addition and deduction below or above normal temperature.

(c) *Temperature.* All crude petroleum shall be delivered ready for sprinkling at a temperature of not lower than 150° Fahrenheit or above 190° Fahrenheit, and in determining the quantity of petroleum delivered, the correction and expansion by heat shall be as follows: In all crude petroleum received at any temperature above 60° Fahrenheit an amount equivalent to 0.4 of one per cent for every 10° Fahrenheit shall be subtracted from the observed volume as the correction for expansion by heat. For the purpose of measuring crude petroleum a temperature of 60° shall be deemed normal temperature.

(d) *Asphalt.* All crude petroleum shall contain not less than seventy per cent "D" grade asphalt, California standard.

(e) *Test For Asphalt.* The sample of oil shall be placed in an evaporating dish and heated in a hot-air oven at 400° Fahrenheit, until it is reduced to "D" grade asphalt, California standard. The residue is weighed and the per cent of asphalt calculated.

(f) *Water and Sediment.* All crude petroleum shall be tested for water and sediment.

(g) *Test For Water and Sediment.* The "gasoline test" shall be used to determine the amount of water and sediment. Said test shall consist of equal parts of crude petroleum and 68° Baumé gasoline, mixed in a glass-stoppered glass cylinder and left to stand twenty-four hours; thereupon reading shall be taken and the percentage of water and sediment determined.

(h) *Deductions.* Deductions for water and sediment in crude petroleum will be made in exact proportion to the percentage of such water and sediment found. Deductions for shortage in volume will be made in the exact number of gallons tank wagons are found to be short on delivery.

(i) *Tank Wagons.* All tank wagons used for delivering the crude petroleum must first be submitted to the street superintendent, who shall gauge and stamp into the steel head of said tanks the capacity in gallons said tanks will contain, and no figures of capacity will be accepted other than the official rating given by the street superintendent.

(j) All oil to be used shall be tested by an oil inspector employed by the street superintendent for that purpose.

(k) Oil shall be tested at tanks before delivery upon work, and if same shall not comply with specifications, it shall not be delivered at the work.

5. CULVERTS.

Culverts shall be placed wherever designated on the profiles or plans of the street on file in the office of the City Engineer. They shall be of the character and dimensions shown in the profile or plan and described in the specifications named in the ordinance of intention.

APPENDIX B.

GENERAL SPECIFICATIONS FOR GRADING AND OIL PAVING STREETS WITH CRUDE OIL WITH THE USE OF THE TAMPING ROLLER, IN THE CITY OF SANTA MONICA, CAL.

I.

Contractors shall use the tamping roller approved by the Superintendent of Streets and Board of Trustees of the City of Santa Monica for all work under these specifications.

II.

The streets shall be plowed to a depth of six inches and graded evenly with a crown to conform to the established height at center of street, and properly pulverized with said tamping roller. Said tamping roller shall be weighted from two to three tons, and to form a solid base up to four inches from top.

III.

Where there is no cement or paved gutter, then the gutter three feet wide out from curb shall be done in the following manner: Remove the earth six inches deep below finished grade by the use of a grading machine, leaving earth so removed in the street; then loosen bottom lightly, apply water sufficiently; then apply $1\frac{1}{2}$ gallons of oil to each square yard of surface, evenly; refill three inches of loose earth, and water sufficient; tamp this evenly and solid, by using a wagon or truck with four-inch width of tires, weighted sufficiently to make a solid base; then back fill to grade. Gutters at street intersection, as indicated by plans, shall be of double width and constructed as hereinbefore mentioned.

IV.

When the street is properly graded, pulverized, and tamped solid to within four inches from the top, then apply water sufficient to thoroughly and evenly dampen to a proper consistency, four inches deep; loosen with a cultivator lightly set so as not to disturb sub base; then the oil shall be applied as follows: The street shall be coated evenly with oil at the rate of three fourths of the amount to be used; then plow the oil under four inches deep with a gang plow, commencing at center of street; then harrow diagonally two ways, and then tamp with tamping roller weighted to penetrate four inches evenly and solid to within one and one-half inches of the top; then run a road grader or scarifier over entire surface lightly, to make the street an even grade; then harrow and apply sufficient water; then apply the second coat of one fourth of the amount of oil to be used, evenly spread over entire surface of street; then harrow and tamp with tamping roller evenly and solid to top; then tamp gutters eighteen inches wide out from curb with a wagon or truck weighted with four tons, as hereinbefore specified. The work and material under this section to be done the full width of the street and over the oil base of gutters as specified in Section III of these specifications.

Wherever, upon any street or alley, any cement crosswalks, cement gutters, or any paving and machine work are impracticable, then the same shall be done in same manner by hand work under the direction of the superintendent of streets.

The contractor will be held responsible for all damages to curbs, gutters, crosswalks, flumes, etc., that may be caused by him in the performance of the work. When water or oil is to be applied the condition of the soil shall be subject to the approval of the superintendent of streets. The contractor shall be required to examine all plans for the above work on file in the office of the City Engineer.

V.

The quantity of crude oil to be applied to be two and a half gallons for every square yard of surface of heavy soil, and three gallons for every square yard of light sandy soil, unless otherwise specified, from curb to curb, where there is no gutter, and where there are cement or paved gutters, then from gutter to gutter, and at all intersections of streets and alleys to property line on both sides.

VI.

The oil shall be from 12° to 14° gravity, Baumé test, at a temperature of 60° Fahrenheit, and contain from forty (40) per cent to sixty (60) per cent of "D" grade asphalt, to be subject to the gasoline test for water and foreign matter, and not to contain over two (2) per cent of water or foreign matter, and heated to a temperature sufficient to run freely from a sprinkler or tank; provided, however, that in dry or dusty soil twenty gallons of water must be used every nine square feet of road surface before applying the oil. The contractor shall provide an analysis of oil furnished when called for by the street superintendent.

VII.

To insure the quality and quantity of all oil used under these specifications, the contractor shall deliver said oil into the city's tanks at the corporation yard, there to be tested for gravity, water, and foreign substance, by the street superintendent or his assistant, whose duty it shall be, after said tests are made, to heat, measure, and deliver said oil into such tank wagons as may be used to deliver and spread the oil on the street; and oil so handled at city tanks shall be subject to a charge of ——— cents per barrel, said charge to be paid by the contractor to the City of Santa Monica. A complete record of all these transactions shall be kept by the street superintendent.

VIII.

The contractor shall erect a fence and keep erected a proper barrier along the line of said work and across the ends of same both day and night, and to maintain red lights between sunset and sunrise, and post all legal notices and signals as to the state of the roadway or street during the prosecution of the work.

Reference is hereby made to the general specifications now in force for the grading of streets within the City of Santa Monica, including all ordinances, etc.

IX.

The work shall be performed under the supervision of the City Engineer and street superintendent. Also subject to the approval of the Board of Trustees of the City of Santa Monica, or their authorized agents.

APPENDIX C.

SPECIFICATIONS FOR DESERT GUIDEPOSTS.

KIND OF POST.

All parts shall be galvanized iron except the brass collar containing the penalty clause. All dimensions are shown on the drawing.

SIGNBOARDS.

Each post shall have two signboards. Such boards shall each be reinforced by a 5-inch by 8-inch by $\frac{1}{8}$ -inch galvanized plate. The bolt holes through the galvanized iron signboard shall be drilled or punched in connection with and at the same time as the reinforcing plate.

BOLTS.

The bolts shall be of neatly finished lengths, so that the nuts will not have an excessive length of bolt protruding.

BOLT UNDER BRASS COLLAR.

Under the brass collar there shall be screwed into the pipe or post proper a five-sixteenths inch bolt for the purpose of holding the collar and boards in place vertically.

FITTING AND WORKMANSHIP.

All fittings and all workmanship on the construction of the posts must be first class in every particular.

GENERAL CONDITIONS.

No deviation from the drawing will be allowed without the permission of the State Highway Commissioner.

All posts shall be delivered in a "knocked down" shape and properly prepared for shipment.

Examination of Work. The contractor must furnish all facilities to the State Highway Commissioner, or agent, to examine and determine whether the posts are as specified.

Contractor's Duty. The contractor must abide by and comply with the obvious intent and meaning of these specifications, which shall be construed to include all materials and modes of work necessary to complete the work on the posts herein specified in a thorough and workmanlike manner.

Errors or Omissions. The contractor will not be allowed to take any advantage of any error or omission in these specifications, as full instructions will be given him should any error or omission be discovered.

Disputes, Etc. All work must be done to the satisfaction of the State Highway Commissioner; and all questions and disputes with regard to the intent and interpretation of these specifications shall be referred to him, and his decision thereon shall be final.

Non-Compliance with Specifications. Should any post or posts be made not in accordance with these specifications, the same shall be rejected.

Non-Liability of State. All bills incurred by the contractor for the employment of labor, purchase of material, or any other matter in connection with the work provided for in these specifications, must be paid by said contractor, and the State of California is hereby expressly relieved from any indebtedness or claim due to any person other than the contractor for any amount of money over and above the contract price.

Time of Furnishing Posts. The posts must be delivered in lots to suit, after reasonable notification by the State Highway Commissioner, at any time after the award of the contract, not later than May 1, 1906.

INSTRUCTIONS TO BIDDERS.

Rejection of Bids. The Highway Commissioner reserves the right to reject any and all bids, and to waive any informality in any bid received.

Address for Bids. All bids should be addressed to the State Highway Commissioner, Room 73, State Capitol, Sacramento, California.

Bids, Etc. One copy of the advertisement, the guarantee, and the specifications must be securely attached to each bid, and considered as comprising a part of it.

Check for Cash Bond. Each bid must be accompanied by a certified check in the sum of two hundred and fifty (250) dollars, payable to the order of N. Ellery, State Highway Commissioner, and drawn on some established bank doing business in the State of California. Before awarding the contract, all of said checks deposited by the unsuccessful bidders shall be returned to them by the said N. Ellery, State Highway Commissioner. The check deposited by the successful bidder shall be retained by said N. Ellery, until ten (10) days after the delivery of the posts provided for in the plan and specifications, and their full acceptance by the State Highway Commissioner. Said certified check shall be a cash bond for the faithful performance of the work under the contract, and in case of the violation of the plan and specifications said bond shall be forfeited by said contractor to the State of California, or such part of it as is deemed necessary to insure the State of California against loss.

Form of Bid. All bids shall be upon forms supplied by the office of the Department of Highways.

Time to Make Contract. The bidder to whom the contract under these specifications shall be awarded shall, within five (5) days after notice of such award be given, sign a contract with the State of California for the execution of the work under the terms of the specifications. Failure to do so within said limit of time shall cause forfeiture of the certified check deposited with the bid to the State of California.

Bids for Posts. Each bidder must state in his proposal a specific sum for which he will make and deliver at Sacramento on cars, 300 posts, herein described, and shall further stipulate the price of each additional post above said number and thereafter.

PAYMENT.

After complete inspection and acceptance by the State Highway Commissioner or his authorized agent, the posts will be paid for as delivered at Sacramento, out of the appropriation for the purpose. The inspection shall be made at the shop where made.

APPENDIX D.

FINANCIAL STATEMENT OF THE DEPARTMENT OF HIGHWAYS.

(NOVEMBER 30, 1906.)

Mono Lake Basin Road.

1899—Appropriation (construction).....	\$25,000 00
1906—Expenditures to November 30.....	24,999 95
Balance	<u>\$0 05</u>
1903—Appropriation (construction).....	\$25,000 00
1906—Expenditures to November 30.....	14,071 58
Balance	<u>\$10,928 42</u>
1905—Appropriation (maintenance) fifty-seventh and fifty-eighth fiscal years	\$1,000 00
1906—Expenditures to November 30.....	959 26
Balance	<u>\$40 74</u>
1905—Expenditures from Touhey bond.....	\$1,000 00
Aug. 8—T. Silvester, foreman.....	\$118 00
A. Silvester, labor.....	85 50
R. Hunter, labor.....	51 65
A. Allen, labor.....	54 15
L. Amiot, labor.....	58 00
J. Trotter, labor.....	59 00
Team hire.....	57 50
Chas. Kordrof, labor.....	9 65
J. P. Hammond, mdse.....	68 09
Jerome Labraque, vegetables.....	2 50
Joe Scanavino.....	2 50
T. Silvester, team.....	18 00
J. S. Cain, mdse.....	77 25
Sept. 19—T. Silvester, foreman.....	50 00
A. Silvester, labor.....	31 87
R. Hunter, labor.....	25 00
L. Amiot, labor.....	25 00
J. Trotter, labor.....	24 00
Team of T. Silvester.....	25 50
Chas. Kordrof, labor.....	25 00
Wm. Saulsbury, labor.....	36 00
M. Kinney, labor.....	37 65
Balance	<u>941 81</u>
Balance	<u>\$58 19</u>

Trinity-Humboldt Road.

1903—Appropriation (survey).....	\$1,800 00
1906—Expenditures to November 30.....	1,685 85
Balance	<u>\$114 15</u>

Sonora and Mono Road.

1905—Appropriation (bridges).....	\$20,000 00
1906—Expenditures to November 30.....	6,660 55
Balance	<u>\$13,339 45</u>

1905—Appropriation (maintenance) fifty-seventh and fifty-eighth fiscal years	\$8,000 00
1906—Expenditures to November 30.....	7,546 77
Balance	<u>\$453 23</u>

Alturas and Cedarville Road.

1905—Appropriation (construction).....	\$7,000 00
1906—Expenditures to November 30.....	6,927 67
Balance	<u>\$72 33</u>

Lake Tahoe Wagon Road.

1905—Appropriation (bridges).....	\$6,000 00
1906—Expenditures to November 30.....	5,149 65
Balance	<u>\$850 35</u>

1905—Appropriation (maintenance) fifty-seventh and fifty-eighth fiscal years	\$8,000 00
1906—Expenditures to November 30.....	6,677 30
Balance	<u>\$1,322 70</u>

Kings River Canon Highway.

1905—Appropriation (survey).....	\$25,000 00
1906—Expenditures to November 30.....	2,513 34
Balance	<u>\$22,486 66</u>

Desert Guideposts.

1905—Appropriation	\$5,000 00
1906—Expenditures to November 30.....	2,355 84
Balance	<u>\$2,644 16</u>

Traveling and Contingent.

1905—Appropriation, fifty-seventh and fifty-eighth fiscal years.....	\$1,000 00
1906—Expenditures to November 30.....	585 32
Balance	<u>\$414 68</u>

Printing.

1905—Appropriation, fifty-seventh and fifty-eighth fiscal years.....	\$750 00
1906—Expenditures to November 30.....	22 00
	<hr/>
Balance	\$728 00
(Cost of printing Biennial Report not yet deducted.)	<hr/>

El River Protection.

1903—Appropriation	\$5,000 00
1906—Expenditures to November 30.....	5,000 00
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1905—Appropriation	\$32,000 00
1906—Expenditures to November 30.....	32,000 00
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APPENDIX E.

Statement of the Amounts of Taxes Levied in 1905 in the Several Counties of California for County Road Purposes, to be Expended by the Boards of Supervisors during the Fiscal Year 1906-1907.

Counties.	Value of Property Taxed for Road Purposes.	Rate on Each \$100 of Valuation.	Amount.
Alameda	\$28,120,779	\$0.40	\$112,483 12
Alpine	468,385	.40	1,873 54
Amador	5,450,322	.35	19,076 13
Butte	14,847,841	.40	59,391 36
Calaveras	6,085,400	.315	19,169 01
Colusa	11,433,874	.35	40,018 56
Contra Costa	19,331,212	.34	65,726 12
Del Norte	2,903,295	.35	10,161 53
El Dorado	4,261,580	.35	14,915 53
Fresno	28,406,598	.30	85,219 79
Glenn	9,985,730	.25	24,964 33
Humboldt	17,624,063	.40	70,496 25
Inyo	2,265,905	.25	5,664 76
Kern	21,153,000	.24	50,767 20
Kings	6,623,104	.33	21,856 24
Lake	3,015,635	.50	15,078 18
Lassen	5,240,363	.38	19,913 38
Los Angeles	46,965,062	.60	281,790 37
Madera	7,438,381	.32	23,802 82
Marin	8,937,323	.35	31,280 63
Mariposa	2,257,871	.40	9,031 48
Mendocino	10,104,271	.40	40,417 08
Merced	13,977,055	.40	55,908 22
Modoc	4,266,092	.35	14,931 32
Mono	1,236,349	.24	2,967 24
Monterey	15,810,490	.40	63,241 96
Napa	9,208,409	.35	32,229 43
Nevada	5,207,740	.40	20,830 96
Orange	9,889,118	.40	39,556 47
Placer	8,251,323	.40	33,005 29
Plumas	4,222,524	.56	23,646 13
Riverside	7,796,622	.50	38,983 11
Sacramento	16,675,055	.374	62,364 71
San Benito	5,517,224	.33	18,206 84
San Bernardino	13,963,752	.50	69,818 76
San Diego	9,285,726	.60	55,714 36
San Francisco	No expenditures on county roads.		
San Joaquin	23,172,540	.40	92,690 16
San Luis Obispo	11,987,100	.40	47,948 40
San Mateo	15,517,507	.492	76,346 13
Santa Barbara	12,768,798	.40	51,075 19
Santa Clara	33,506,999	.40	134,028 00
Santa Cruz	6,857,666	.45	30,859 50
Shasta	10,418,065	.40	41,672 26
Sierra	1,605,243	.44	7,063 07
Siskiyou	11,282,950	.40	45,131 80
Solano	14,080,046	.40	56,320 18
Sonoma	23,053,700	.35	80,687 95
Stanislaus	13,004,389	.40	52,017 56
Sutter	6,588,234	.35	23,058 82
Tehama	10,486,223	.35	36,701 78
Trinity	2,271,890	.40	9,087 56
Tulare	15,960,910	.35	55,863 19
Tuolumne	6,474,740	.57	36,906 02
Ventura	8,437,522	.40	33,750 09
Yolo	14,560,082	.40	58,240 33
Yuba	4,017,237	.40	16,068 95
Totals	\$634,279,314	-----	\$2,540,019 15

APPENDIX F.

Statement of the Amounts of Taxes Levied in 1906 in the Several Counties of California for County Road Purposes, to be Expended by the Boards of Supervisors during the Fiscal Year 1907-1908.

Counties.	Value of Property Taxed for Road Purposes.	Rate on Each \$100 of Valuation.	Amount.
Alameda	\$29,461,545	\$0.40	\$117,846 18
Alpine	488,314	.55	2,685 73
Amador	4,452,937	.36	16,030 57
Butte	13,976,514	.40	55,906 06
Calaveras	6,396,945	.332	21,237 86
Colusa	11,394,970	.35	39,882 40
Contra Costa	17,644,672	.35	61,756 35
Del Norte	2,947,367	.30	8,842 10
El Dorado	4,361,149	.36	15,700 14
Fresno	30,086,602	.40	120,346 41
Glenn	10,096,380	.30	30,289 14
Humboldt	17,658,599	.40	70,634 40
Inyo	2,530,045	.35	8,855 16
Kern	22,691,169	.25	56,727 92
Kings	6,975,569	.33	23,019 38
Lake	3,215,136	.464	14,918 23
Lassen	5,218,537	.40	20,874 15
Los Angeles	58,955,625	.60	353,733 75
Madera	7,598,854	.37	28,115 76
Marin	9,387,388	.35	32,855 86
Mariposa	2,121,845	.40	8,487 38
Mendocino	9,677,951	.40	38,711 80
Merced	14,371,941	.40	57,487 76
Modoc	4,292,297	.32	13,735 35
Mono	1,042,450	.30	3,127 35
Monterey	16,094,445	.40	64,377 78
Napa	9,597,379	.32	30,711 61
Nevada	5,336,966	.50	26,684 83
Orange	11,121,014	.40	44,484 06
Placer	8,190,990	.40	32,763 96
Plumas	4,294,678	.56	24,050 20
Riverside	9,454,570	.50	47,272 85
Sacramento	16,892,062	.40	67,568 25
San Benito	5,687,440	.33	18,768 55
San Bernardino	17,484,051	.40	69,936 20
San Diego	9,893,862	.60	59,363 17
San Francisco	No expenditures on county roads.		
San Joaquin	25,479,332	.40	101,917 33
San Luis Obispo	12,623,797	.40	50,495 19
San Mateo	16,868,911	.502	84,681 93
Santa Barbara	12,876,160	.40	51,504 64
Santa Clara	35,368,923	.40	141,475 69
Santa Cruz	7,001,800	.45	31,508 10
Shasta	11,486,598	.40	45,946 39
Sierra	1,704,758	.50	8,523 79
Siskiyou	12,254,679	.35	42,891 38
Solano	13,903,314	.40	55,613 26
Sonoma	23,549,263	.36	84,777 35
Stanislaus	13,300,400	.40	53,201 60
Sutter	6,753,936	.35	23,638 78
Tehama	10,827,458	.38	41,144 34
Trinity	2,256,667	.40	9,026 67
Tulare	16,687,132	.40	66,748 53
Tuolumne	6,435,560	.60	38,613 36
Ventura	9,023,682	.40	36,094 73
Yolo	14,769,438	.40	59,077 75
Yuba	4,213,206	.40	16,852 82
Totals	\$668,277,272	-----	\$2,751,522 28

